Guidelines for the Specialized Master's degree program Data Science

at the Faculty of Science of the University of Basel

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1 Overview

The University of Basel offers a two-year Specialized Master's degree program Data Science. The present guidelines explain and supplement the *Study regulations for the Master's program at the Faculty of Science of the University of Basel* dated 15.09.2020, hereafter referred to as Rahmenordnung Master, as well as the *Study program for the Specialized Master's program Data Science* dated 16.11.2021, hereafter referred to as study program Data Science.

The present guidelines refer to the relevant paragraphs in these documents in square brackets, e.g., [Rahmenordnung Master §11].

1.1 Profile

The studies in Data Science at the University of Basel opens up a wide range of careers in business and industry as Data Analysts / Data Scientists, but also provides the basic theoretical knowledge needed for entering a career in research and academia. Graduates of the Master's program Data Science are able to systematically analyze large data sets ("Big Data") and extract new insights from these data. They know the current state in Machine Learning, Applied Statistics and Distributed Systems, and they are also prepared to deal independently with the permanent change in this dynamic field.

1.2 Degrees

The two-year program in Data Science concludes with the degree of Master of Science in Data Science. This Master's degree can be complemented through an independent research work (dissertation) by a PhD in Computer Science or Mathematics, in particular in the context of the PhD Program Data Science at the Department of Mathematics and Computer Science, or in any other related field.

1.3 Beginning of studies

The Master's program Data Science can be started in the fall or the spring semester [Rahmenordnung Master § 4]. However, due to the sequence of the courses to be attended, a start in the fall semester is highly recommended.

1.4 Credit points and duration

The Master's program Data Science is structured according to the Bologna Declaration and it is internationally recognized. Credit points are assigned to all courses and are earned upon satisfactory performance. Passing the Master's program Data Science requires the acquisition of 120 credit points (CP). Hence the Master's program lasts four semesters in full-time study. However, the credit points can also be acquired during a longer self-selected period of time. This makes it possible, for example, to work while studying or to extend the study period for family reasons. In general, there are no specifications to the period of time within the necessary credit points must be earned.

The assignment of credit points is based on the European Credit Transfer System (ECTS). The annual study time corresponds to 60 credit points, i.e., 1 CP is awarded for 30 hours of work (presence at courses plus individual preparatory and follow-up work). By specifying credit points for the individual courses, the average amount of work to be done becomes evident. This makes the studies more transparent, easier to plan, and easier to evaluate in case of a transfer to another university.

1.5 Admission

Admission to the Specialized Master's degree program Data Science requires a Bachelor's degree in Computer Science, Mathematics, or Computational Sciences from a Swiss university with an average degree of 5.0 (with the Swiss grading system as a reference). Graduates from one of these programs of the University of Basel are admitted without requirements if they have the knowledge in Mathematics and Computer Science of at least 75 CP from the following areas:

- Analysis and Linear Algebra (at least 20 CP)
- Numerical Analysis (at least 4 CP)
- Probability and Statistics (at least 8 CP)
- Programming (at least 12 CP)
- Algorithms and Data Structures (at least 6 KP)
- Databases (at least 4 CP)
- Scientific Computing / Pattern Recognition / Machine Learning (at least 6 CP)
- Scientific Communication (at least 3 CP)

For all other Bachelor's degrees from a recognized university, the Curriculum Committee Data Science verifies the equivalence to the required knowledge in Mathematics and Computer Science according to the aforementioned list. For the equivalence of the acquired knowledge, the Bachelor's degrees in Computer Science and Mathematics from the University of Basel serve as a reference.

If the requirements are only partly met, the Curriculum Committee can suggest admission requirements which are defined by the President's board upon request of the examination commission of the Faculty of Science [Rahmenordnung Master §3]. For candidates having no average grade for the Bachelor's degree, the Curriculum Committee will assess the equivalence to an average grade of 5.0.

1.6 Examinations

The Rahmenordnung Master lists various types of assessment formats for the acquisition of credit points. With a few exceptions, each course is examined in oral or written form. Detailed information can be found in [Rahmenordnung Master §§10–15].

1.7 Language

The language of instruction of the Master's program is English.

1.8 Mobility

One or more exchange semester at another university, especially abroad, or internships abroad were supported by the curriculum committee.

But it is highly recommended to clarify up the recognition of credits and grades with the curriculum committee previously.

The recognition of the passed exams and the credit points at other higher education institutions is regulated in [Rahmenordnung Master §22].

2 Master's program Data Science

2.1 Structure of the Master's program Data Science

The Master's program is structured in modules, which combine courses into a coherent unit. Figure 1 schematically shows the modules of the Master's program Data Science.

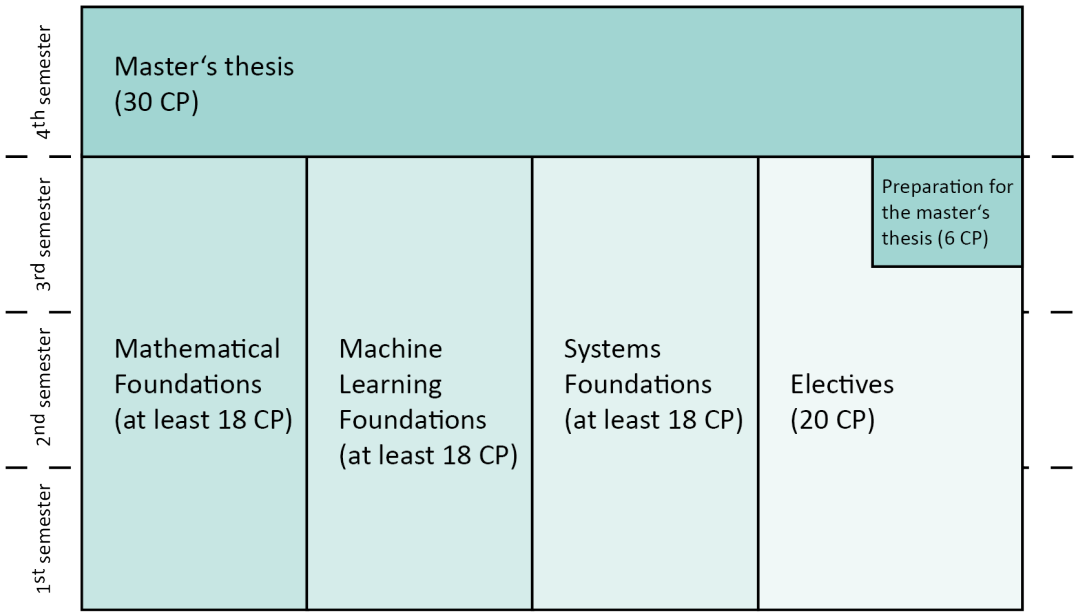

Figure 1: Structure of the Master's program Data Science

In each module, at least the specified number of credit points must be earned through successful completion of associated courses. Some modules include mandatory courses, which are marked accordingly in the following sections. The courses offered may vary; the course directory shows for each module which courses are offered in the current semester.

Below, the mandatory courses of each module are marked by **(+)**. They are listed together with the other courses that may be taken. For each course, the list contains in brackets the course number according to the course directory and the number of credit points.

In the three modules *Mathematical Foundations, Machine Leaning Foundations*, and S*ystems Foundations*, in total 64 CP have to be earned. However, the minimum requirement in each module comprises 18 CP. This means that in total 10 CP can be freely and individually distributed to one or several of these modules. This allows the students to put their focus on the module(s) of their preference and allows for a specialization within the Master's program Data Science.

In the modules *Machine Learning Foundations* and *Systems Foundations*, either 6 or 12 CP can be earned according to Master's projects. Details of the Master's projects (content, start and end date, submission details) are specified in a learning contract to be established with one of the lecturers from the corresponding module.

2.1.1 Module *Mathematical Foundations* (at least 18 CP)

This module encompasses the basic compulsory mathematics courses for Data Scientists:

- **(+)** Mathematics of Data Science (66096, 8 CP)
- Statistical Modeling (55769, 6 CP)
- Iterative Verfahren der Numerik (22738 & 22740, 4 + 4 CP)
- Causal Inference (57241, 6 CP)
- Applied Stochastic Processes (60877, 6 CP)

In addition, other courses may be offered that are linked to this module in the course directory. In this case, students are free to choose in which courses the at least 18 CP of the module are acquired.

2.1.2 Module *Machine Learning Foundations* (at least 18 CP)

This module encompasses the basic courses for Data Scientists from a machine learning point of view:

- **(+)** Machine Learning (17165, 8 CP)
- High-Dimensional Data Analysis and Learning on Graphs (60835, 6 CP)
- Foundations of Artificial Intelligence (13548, 8 CP)
- Machine Learning Project (learning contract, 6 or 12 CP)

In addition, other courses may be offered that are linked to this module in the course directory. In this case, students are free to choose in which courses the at least 18 CP of the module are acquired.

2.1.3 Module *Systems Foundations* (at least 18 CP)

This module encompasses the basic courses for Data Scientists from a systems point of view:

- **(+)** Foundations of Distributed Systems (45402, 8 CP)
- Distributed Information Systems (15729, 4 CP)
- High Performance Computing (17164, 4 CP)
- Multimedia Retrieval (15731, 6 CP)
- Systems Project (learning contract, 6 or 12 CP)

In addition, other courses may be offered that are linked to this module in the course directory. In this case, students are free to choose in which courses the at least 18 CP of the module are acquired.

2.1.4 Module *Electives in Data Science* (20 CP)

This module aims at providing insights into application domains in which Data Science methods are applied. The courses of this module are listed in the course directory. In addition, the following courses can be chosen in this module and students can decide if they do an application-oriented Data Science project of 6 or 12 CP:

- Seminar Scientific Writing (17163, 6 CP)
- Data Science Project (learning contract, 6 or 12 CP)

2.1.5 *Preparation for the Master's thesis* (6 CP)

The *Preparation for the Master's thesis* is usually carried out in the third semester after the end of the lecture period and serves to familiarize students with the topic of the Master's thesis, in particular with the state-of-the art in the methods to be applied, the application domain, and the data set to be used.

For this purpose, a learning contract is established in individual agreement with a professor of the Master's degree program Data Science, which regulates the topic, start and submission date as well as the form of submission. As a guideline, it should be possible to complete the *Preparation for the Master's thesis* in one month (full-time). The *Preparation for the Master's thesis* is completed with a presentation of the results and the project plan and is evaluated with pass/fail.

The details for the preparation of the Master's thesis are regulated in [Rahmenordnung Master §15 and study program Data Science].

2.1.6 Master's thesis (30 CP)

The Master's thesis can only be started after the *Preparation for the Master's thesis* has been successfully completed and at least 76 CP have been earned in the modules *Mathematical Foundations*, *Machine Learning Foundations*, *Systems Foundations*, and *Electives in Data Science*. A current progress summary has to be submitted to the docent by establishing the learning contract.

The Master's thesis usually takes 6 months. The written dissertation of the Master's thesis must be submitted in electronic form and the results must be presented in a 30-minute presentation. This presentation usually takes place shortly after the submission of the written report. At the time of the presentation, all 84 CP from the modules *Mathematical Foundations*, *Machine Learning Foundations*, *Systems Foundations*, and *Electives in Data Science* must have been earned. Details on the topic, form of submission, scope, start and submission dates of the Master's thesis are specified in a learning contract. The Master's thesis is graded (1.0 – 6.0). A failed Master's thesis can be repeated once with a new topic.

Details on the Master's thesis are regulated in [Rahmenordnung Master §15 and study program Data Science].

2.2 Possible enrollment

Table 1 shows an example of how the Master's degree program Data Science can be completed within two years. The courses listed are examples, the courses actually chosen may differ due to the current offer and personal preferences and specializations.

Table 1: possible enrollment of the Master's program Data Science

Semester	Module	Course	CP
1. (HS)	*Mathematical Foundations*	Mathematics of Data Science	8
		Statistical Modeling	6
	Systems Foundations	Foundations of Distributed Systems	8
	Electives in Data Science	Individual decision	8
2. (FS)	*Mathematical Foundations*	Causal Inference	6
		Applied Stochastic Processes	6
	Machine Learning Foundations	Machine Learning	8
		High-Dimensional Data Analysis and Learning on Graphs	6
	Systems Foundations	Distributed Information Systems or High Performance Computing	4
3. (HS)	*Machine Learning Foundations*	Machine Learning-Project	6
	Systems Foundations	Multimedia Retrieval	6
	Electives in Data Science	Individual decision	6
		Scientific Writing	6
	Preparation for the Master's thesis	Individual, according to a learning contract	6
4. (FS)	*Master's thesis*	Individual, according to a learning contract	30
Total			120

2.3 Passing the Master's program and Master grade

In order to pass the Master's program, at least the specified number of credit points must be earned in each module. In addition, the sum of the credit points in the modules *Mathematical Foundations*, *Machine Learning Foundations*, and *Systems Foundations* must be 64 CP. There is no possibility of compensation.

All modules except the *Preparation for the Master's thesis* and the *Electives in Data Science* are graded. The grade of each module is calculated from the average of the course grades within the module [study program Data Science] weighted by credit points. The Master's grade is calculated on the basis of the module grades as well as the Master's thesis with the following weights [study program Data Science]:

- Grade of the module *Mathematical Foundations*: 1/6
- Grade of the module *Machine Learning Foundations*: 1/6
- Grade of the module *Systems Foundations*: 1/6
- Grade of the Master's thesis: 1/2

3 Quality assurance

The quality of the courses offered is evaluated regularly according to the guidelines for course evaluation in the degree programs of the Faculty of Science of the University of Basel.

4 Recognition of credits and grades

The examination commission decides on the recognition of comparable credits and grades acquired on another degree program of the University of Basel or on another higher education institution. The same or similar achievements could only be recognized once. The extent of the recognized external credits and grades must not outstrip half of the requested study achievements. A previous Master's thesis can't be recognized.

Procedure: a written request with a detailed assembly of the recognizable credits and grades has to be submitted to the Office of the Dean of Studies. All certificates for the performed credits and grades have to be attached to the proposal with a short summary.

The recognition of credits and grades will be communicated to the persons concerned in written form by the Office of the Dean of Studies.

5 Validation

These guidelines apply to all students in the Specialized Master's program Data Science starting at 1st August 2022 or later.

6 Degree program relevant documents and units / study advice

6.1 Documents

Admission requirements and description of the degree programs at the University of Basel were regulated in regulations, study programs and guidelines and are available in the internet. (https://www.unibas.ch/de/Dokumente.html).

The **Student regulations of the University of Basel** regulate among other things the degree levels and grades, the acquisition of credit points, the recognition of credits and grades, changes of personal information, E-Mail account, admission to the degree programs, matriculation, application and semester registration as well as general rights and duties of the students. Detailed information concerning the application procedure for the studies can be found in the internet (www.unibas.ch/de/Dokumente.html).

The **Study regulations for the Master's program at the Faculty of Science of the University of Basel** (Rahmenordnung Master) regulates the general details of the offered Master's degree programs (www.unibas.ch/de/Dokumente.html or https://philnat.unibas.ch).

The **Study program for the Specialized Master's degree program Data Science** (study program Data Science) datetd 16.11.2021 regulates the Master's program Data Science (www.unibas.ch/de/Dokumente.html or https://philnat.unibas.ch). The study program Data Science is completed and elucidated by the present guidelines.

The curriculum committee Data Science is responsible for the Master's degree program. The duties and responsibilities as well as the constitution of the curriculum committee is regulated in [Rahmenordnung Master §23 and study program Data Science].

6.2 Units / study advice

Degree program coordination

Dr. Sabine Meinel

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The degree program coordination is responsible for student advice and provides information about the degree program structure, study focus, recognition of credits and grades, mobility, questions concerning the study regulations and guidelines.

Website for the Master's program Data Science

www.dmi.unibas.ch/de/studium/data-science/

Head of the curriculum committee Data Science

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