



Degree program description for the
Bachelor's degree program in Data Science
at the Catholic University of Eichstätt-Ingolstadt

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A. General structure of the degree program

The name of the degree program is:	Data Science
Responsible faculty:	Faculty of Mathematics and Geography
Involved faculty/faculties:	Ingolstadt School of Management Faculty of Philosophy and Education
Degree:	Bachelor of Science
Mode of study:	☒ Full-time program ☐ Part-time program ☐ Full- and part-time program ☐ Cooperative study program ☐ Distance learning program
Type of degree program:	☒ Undergraduate program ☐ Consecutive program ☐ Professional development program
Standard length of the program:	6 semesters (full-time)
Start of the program:	☐ Summer semester ☒ Winter semester
Number of ECTS credits to be awarded:	180 ECTS credits
Tuition fees:	☒ No ☐ Yes, € per semester



B. Description of the degree program

1. The degree program in three sentences

The successes of artificial intelligence - and machine learning in particular - demonstrate the potential of mathematical and statistical methods to automatically discover underlying correlations in large amounts of data and to make them usable. The BSc program in Data Science teaches the fundamentals of machine learning and other current data science methods and the ability to efficiently apply these methods using modern software technologies. The choice of a specialization allows students to deepen their mathematical foundations and/or broaden their field of study towards an area of application.

2. Target group

Prospective students with a completed general or subject-specific German university entrance qualification or equivalent foreign qualification who wish to acquire a mathematically substantiated education in machine and statistical learning as well as numerical and data analysis methods. Due to the use of the English language in the program, it is suitable for German students who value an international orientation in their studies and to students from abroad.

3. Basic orientation

The program teaches the underlying principles of Data Science in the subject areas

- Mathematics
- Statistics
- Computer Science

and complements these with interdisciplinary courses in the field of

- Data Science

The combination of different subjects demonstrates the interdisciplinary character of the study program. This character is extended by the possibility to choose a specialization in an area of application. Students are thereby provided with an interdisciplinary perspective on data science and of the digital transformation process in companies and society.

Students take courses in one of the following specializations:

- *Applied Mathematics and Scientific Computing*
- *Business Analytics and Operations*
- *Digital Transformation of Society*
- *Environmental Sciences*
- *Finance and Economics*
- *Machine Learning and Statistics*

Contents of the specializations are described in section 1.4 and 2.3.



Skills are taught and knowledge is acquired by means of established and modern teaching concepts, e.g. practical exercises, project work in small groups and lectures with exercise sessions. Thus, students learn working methods and concepts that are used in wide areas of the IT industry and beyond. Graduates of the program will be able to actively shape the ongoing digitalization, both, methodically (e.g., as a data analyst, data engineer) and conceptually (e.g., as a data strategist).

With the competences, knowledge, and personal skills acquired in the program, graduates become valued and sought-after employees for numerous industrial and business sectors, startups, as well as public, non-profit, and non-governmental organizations. Graduates acquire a solid foundation in the program that prepares them for a wide range of disciplinary and interdisciplinary Master's degree programs in mathematics and engineering.

Since most courses are taught in English, graduates are excellently prepared for the increasingly international data science job market.



C. Degree program concept

1. Degree program structure

1.1. Admission requirements

Prerequisite for admission to the Bachelor's degree program in Data Science is a general or subject-specific university entrance qualification. Another entrance requirement is the German language proficiency on A2 level, which must be obtained latest by the end of the first year of study.

The number of available study places is announced annually.

The program is offered primarily in English. If required courses are at some point held in German, students are provided with lecture notes, exams, exercise sheets, and recorded lectures in English. The range of elective courses also includes courses in German. With the possible exception of the specialization *Digital Transformation of Society*, all specializations can be studied without German language skills.

1.2. Qualification objectives

Graduates of the program

- have acquired basic knowledge and a strong intuitive understanding of the areas of mathematics, statistics, and computer science that are essential in the field of data science,
- have sound skills and knowledge in the field of mathematical and statistical data analysis,
- are able to think analytically and in a structured manner and to implement their ideas in the form of computer programs and algorithms,
- can work independently and define goals and work processes autonomously,
- are familiar with a broad spectrum of mathematical-statistical methods for modeling and processing complex problems in data science,
- have practical experience in the application of data analysis and data interpretation methods and information processing concepts,
- are sensitized to ethical issues in connection with data science applications,
- have further developed their foreign language proficiency in English and their technical vocabulary and can express themselves in a structured and fluent manner,
- are team players and can communicate and present complex issues in a targeted manner.

1.3. Opportunities for further qualification

This program qualifies graduates for a subsequent Master's degree in the field of data science. The rapidly growing study offer is illustrated by the following list of Master's degree programs in Germany, most of which are offered in English:

- Mathematics in Data Science (M.Sc.), TU Munich
- Data Science (M.Sc.), University of Leipzig
- Data Science (M.Sc.), FU Berlin
- Data Science (M.Sc.), FAU Erlangen-Nuremberg
- Data Science (M.Sc.), TU Dortmund University
- Data Science (M.Sc.), TU Braunschweig
- Mathematical Data Science (M.Sc.), University of Ulm
- Data Science (M.Sc.), University of Mannheim
- Data Science (M.Sc.), University of Potsdam
- Data Science (M.Sc.), RWTH Aachen University

Furthermore, the Bachelor's program in Data Science offers excellent prerequisites, partly depending on the chosen specialization, for a Master's degree in Applied Mathematics, Statistics, Computer Science, areas of Geosciences, Economics, Business Administration or Operations Research. We recommend that students check the respective admission requirements of the intended programs at an early stage in their BSc studies and to take them into account when choosing elective courses and their specialization.

Continuation of studies at the KU Eichstätt-Ingolstadt is already possible in the Interdisciplinary Master's degree program in Mathematics. The inclusion of Data Science as a subject in this Interdisciplinary Master's program and the development of a stand-alone Master's program in Data Science are currently in preparation.

1.4. Labor market situation and professional fields

Data Science is of fundamental importance for the digital transformation process in the decades to come. In this context, the environment and industry are increasingly permeated with networked information systems and data-collecting devices; in order to benefit from this, the resulting data must be analyzed using modern methods. This entails a need for well-trained data scientists to solve these challenges using new technologies and methods (such as machine learning in artificial intelligence) e.g. in industry, business, start-ups and in the public sector. The labor market needs graduates who have strong analytical thinking and implementation skills, and at the same time are aware of the responsibility in the processing of sensitive data, including the impartiality and objectivity of algorithms.

Possible occupational fields for all profiles in the program are

- Specialist and management positions in occupational areas related to data science and information technology in national and international companies and organizations,
- Cross-sectional tasks in machine learning, data analysis, and forecasting,
- Consulting activities in the above-mentioned areas,
- Academic careers in mathematics, data science, and application areas.

Occupational fields depending on the different specializations are

Applied Mathematics and Scientific Computing

- Tasks in research and development in technical industries
- Development of algorithms and software in companies and organizations,
- Occupations in educational institutions (school, adult education, higher education),
- Employment in analytically oriented management consulting firms.

Machine Learning and Statistics

- Experts in data collection, analysis and interpretation, and forecasting,
- Analytical tasks in finance departments of companies, public institutions, ministries and international organizations.

Environmental Sciences

- Collaboration in research institutes such as the German Aerospace Center and the Alfred Wegener Institute for Polar and Marine Research,
- Work for scientific services such as the German Meteorological Service and the Federal Maritime and Hydrographic Agency (BSH),
- Advising governments and non-governmental organizations such as the Ministry of the Environment and Greenpeace.

Business Analytics and Operations

- Activities in strategic planning and corporate development, especially with a focus on digital transformation processes of companies,
- Experts in data-based optimization and decision support in procurement, production, distribution, logistics and supply chain management,
- Process architects for designing, controlling and coordinating intra- and inter-company flows of goods and information using modern methods of data science and machine learning.

Finance and Economics

- Analytical and decision support activities in finance departments of companies and organizations in the public sector,
- General management tasks in politics, business and the public administration.

Digital Transformation of Society

- Development and application of data analysis methods in market and opinion research,
- Quantitative research for media companies,
- Activity in journalism based on empirical methods,
- Advising political parties, organizations and associations.



2. Program structure

2.1. Fundamental program structure

The standard period of study for the Bachelor of Science in Data Science is six semesters. Students acquire a total of 180 ECTS credits. These are divided into the required area (including an internship in the industry or in research), modules in specializations, and modules in the general required elective area. The studies are complemented by a module in Studium.Pro, a Bachelor's seminar and the Bachelor's thesis.

Students have the possibility to complete part of their studies abroad, preferably during the fifth semester.

Information regarding examination rules is specified in the examination regulations. The exact structure of the program, including specializations, is attached in form of exemplary study schedules in Annex I.

2.2. Required area

The required part of the program teaches fundamental knowledge and basic practical skills in Data Science. The required area is composed of modules in the core fields of Data Science, Mathematics, Statistics and Computer Science. Furthermore, the module *Ethics of Algorithms and Data* is a required module:

Data Science

<i>Data Lab</i>
<i>Ethics of Algorithms and Data</i>
<i>Foundations of Data Science</i>
<i>Foundations of Machine Learning</i>
<i>Hands-on Machine Learning and Data Science</i>
<i>Practical Training</i>

Mathematics

<i>Analysis for Data Science 1</i>
<i>Analysis for Data Science 2</i>
<i>Linear Algebra 1</i>
<i>Linear Algebra 2 and Analytic Geometry</i>
<i>Optimization in Data Science</i>

Statistics

<i>Introduction to Statistics</i>
<i>Introduction to Stochastics</i>
<i>Statistical Learning</i>



Computer Science

<i>Advanced Programming</i>
<i>Algorithms and Data Structures</i>
<i>Basics of Information Systems</i>
<i>Introduction to Programming</i>

Furthermore, students attend a Bachelor's seminar.

2.3. Specialization

Offering specializations gives students the opportunity to further their education in an area of their interest. The chosen specialization helps students in deepening their skills in a core area of data science or in obtaining skills in one of its areas of application.

The following specializations are generally offered:

- *Applied Mathematics and Scientific Computing* provides students with a deeper insight into the mathematical foundations of data science. The focus of the specialization is on mathematical model building on the one hand, and on the other hand the transition from continuous to discrete and thus practically implementable models.
- *Business Analytics and Operations* links the field of study to business administration. In addition to basic knowledge of business administration, e.g. accounting, the focus of this specialization is on data-driven approaches for solving business, organizational and technical problems.
- *Digital Transformation of Society* focuses on applications of data science in the social sciences and the humanities. In addition to basic knowledge, students gain insights into the role of empirical methods, e.g. for sociology and journalism. Substantiated knowledge of data science methods in combination with insights into the social sciences and humanities enables students to critically approach the ongoing digital transformation of society.
- *Finance and Economics* focuses on macroeconomic relationships, global markets, and financial instruments. These areas are heavily influenced by data-based methods. The specialization deepens students' methodological skills by conveying knowledge in area-specific modeling and methods.
- *Environmental Sciences* provides students with insights into data-based environmental and earth sciences. A central aspect is the adaptation of models for dynamic (time-varying) processes such as weather and climate to measured data, which are often only available inaccurately and incompletely.

- *Machine Learning and Statistics* allows students to deepen their understanding of statistical methods and introduces advanced and research-oriented aspects of statistical and machine-learning techniques.

The chosen specialization is shown on the Bachelor's degree certificate. The permissible modules for the specializations are listed in Annex II.

2.4. General required elective area

The general required elective area is designed to broaden the scope of study and allows students to acquire skills that go beyond or are complementary to their undergraduate curriculum. All modules that can be credited to a specialization are also part of the general required elective area. They are supplemented by additional modules as shown in Annex II.

2.5. Required internship

In addition to courses, an internship in the industry or a research internship at the Mathematical Institute for Machine Learning and Data Science or in other departments of the KU Eichstätt-Ingolstadt or other universities is a central component of the program.

2.6. Studium.Pro

Students are required to select one module from the University-wide *Studium.Pro* study offer. Here, KU students approach mainly socially relevant issues in an interdisciplinary context. This experience can provide essential impulses for subject-related work.

2.7. Practical approach

A strong practical orientation is a key characteristic of the program and is reflected in many facets. Two programming courses provide in-depth programming knowledge. Such knowledge is then applied and deepened further in many other courses through appropriate tasks and learning units in the respective subject-related contexts. We particularly emphasize the module "Hands-On Data Science and Machine Learning" in the second semester of study, in which basic algorithms are applied in practice, giving students the chance to develop a comprehensive intuition for their field of study at an early stage. In the further course of study, the "Data Science Lab", in which students work in small teams to approach comprehensive problems, and the above-mentioned "Practical Training" (internship in the industry or research internship) play a central role. Presentation and communication skills are amongst others developed in the "Data Science Lab" and the "Data Science Seminar".

The Bachelor's thesis can be developed in cooperation with a company. An internship in the industry as part of the "Practical Training" offers the opportunity to establish contacts with companies at an early stage and to develop an appreciation for relevant issues.



2.8. Implementation of the internationalization strategy

Since machine learning and mathematical methods are not constrained by national borders, it is a particular concern to place the course in an international context. This is ensured by the following concepts and offers of the program:

- The program is primarily offered in English and thus creates ideal conditions for a career in internationally operating companies. The English-language study program enables the integration of foreign students and creates an enriching international environment.
- Students have the possibility to complete part of their studies abroad. The fifth semester is particularly suitable for this. In this context, students benefit from the University's high number of partner universities that provide suitable study programs. Modules are usually credited in the general required elective area or the specialization.
- When working on group assignments, the goal is to bring together students from different cultural backgrounds. Even a random composition of groups can serve this goal. Thus, the international environment supports students in becoming global citizens.



D. Contribution of the degree program to the KU profile reflected in the Mission Statement for Studies and Teaching

In its Mission Statement, the KU Eichstätt-Ingolstadt aims for a high quality profile of its degree programs which takes into account the criteria *discursive, interconnected, committed*, and which is *tailored to the needs of the individuals*.

The Bachelor's degree program in *Data Science* directly strengthens this profile. The study program is

Discursive:

- The program combines academic standards with practical relevance. This is ensured in all offered specializations.
- The variety of didactic concepts within the courses (lectures, exercises, seminars, etc.) enables a diverse and intensive discourse between theory and practice.
- A major characteristic of the program is to have students actively engage in, reflect on, and question course content.
- The development of course content is based on independent work on exercises, which are then discussed interactively in training groups. The course offerings are supplemented by programming courses and a specialized internship. Here again, the individual exchange between students and lecturers plays a key role.

Interconnected:

- The program is characterized by numerous interdisciplinary links between individual disciplines, in particular Data Science, Applied Mathematics, Statistics, Computer Science, Economics and Environmental Sciences, as well as interdisciplinary issues of the forming digital society.
- International networking is encouraged by the fact that English is the language of study and by providing students with the opportunity to spend a semester abroad. Students are thus also enabled to succeed in an international environment.
- The professional internship provides the opportunity for integration into the social and economic environment of the University.

Committed:

- A key goal of the program is to train students to become professionals and leaders who are aware of their social impact and responsibility and actively embrace both.
- Data Science plays a key role in the social transformation caused by the ongoing second wave of digitalization and holds enormous potential, also with regard to



optimizing the use of resources in terms of sustainability. However, the application of Data Science techniques also involves dangers (e.g. transparent 'glass' human, surveillance capitalism, the consolidation of discrimination by algorithms), which students will reflect upon. On the one hand, this is anchored in the required module *Ethics of Algorithms and Data*. On the other hand, the issue will be approached through situation-specific and topic-related discussions within the framework of the specialized courses and the exchange with the wider University environment. We see the need for the KU to establish a culture of the subject that understands the responsible use of data as a natural part of professional practice.

Tailored to the needs of the individual:

- The program supports mathematical-analytical and algorithmic thinking in students.
- In addition, it promotes students' personal development through the required module *Ethics of Algorithms and Data* and through modules in the *Studium.Pro* area.
- In general, students are offered a close mentoring relationship and excellent staff-to-student ratio. This applies in particular in the context of the seminars and when writing the Bachelor's thesis.

Study plan for the Bachelor's degree program Data Science

1	Intro. Statistics	Intro. Programming	Information Systems	Linear Algebra I		Analysis for DS I
2	Hands-on ML and DS		Algor. & Datastruc.	Linear Algebra II		Analysis for DS II
3	Foundations of Data Science		Adv. Programming	Intro. Stochastics	Optimization for DS	Focus Area
4	Foundations of Machine Learning		DS Lab	Statistical Learning	Studium Pro	Focus Area
5	Practical Training		Ethics for Algorithms and Data	General Elective	Focus Area	Focus Area
6	Thesis		DS BSc Seminar	General Elective	General Elective	Focus Area