University of Regensburg (UR)

Courses taught in English

Faculty of Informatics and Data Science
Study Programs Computer Science and Data Science

Universität Regensburg
INTERNATIONAL OFFICE

Introduction

Information on the Faculty of Informatics and Data Science

The Faculty of Informatics and Data Science (FIDS) at the University of Regensburg focuses its research and teaching on computer science, data science and artificial intelligence. Due to its interdisciplinary structure, FIDS can combine a wide variety of computer science subfields with general computer science: data science, human-centered computing, management information systems, and computational life science. This diversity allows FIDS to think about computer science research objects and methods both specifically and holistically, and to recognize and exploit their potential on a wide variety of levels - for robust, secure, fair, sustainable, user-friendly, and society-enhancing computer systems and computational methods.

This flyer concentrates on the courses offered in English for the study programs Computer Science and Data Science. Management Information Systems offers the possibilities for independent studies. However, this needs to be negotiated individually.

Target Group:

As the Faculty of Informatics and Data Science was founded only recently, the courses are mainly for Bachelor students. Exchange students should be advanced students, however, several courses can also be taken by students in the second year of Bachelor studies as long as they have the required prerequisites. In doubt, we advise students to contact the study advisor for further information: studienberatung.ds@ur.de

Exchange Student Status

Students who come to Regensburg within the framework of an exchange agreement for student mobility benefit from a special student status which allows them to be relatively free with regards to their course choice. They don't need to fulfill full study modules but can register for individual courses which can be recognized at the home institution. In addition, students may also take courses from other areas/faculties at UR, as long as these courses are **relevant to their degree program** at home, and students have the **necessary prior-knowledge** to participate. Furthermore, students are welcome to improve their German language skills by taking part in the program offered by UR's **German as a Foreign Language Unit** (Please see the last page for a link to the course catalog and information on learning German.)

Language Requirements:

Students wishing to take courses from the English-taught course program must have English knowledge at level B2/C1 (according to CEFR) or higher.
Students wishing to take courses from the mixed German-English program must have English knowledge at level B2/C1 and a German level of at least B1 (according to CEFR).

Intensive Language Course in German:

For students who come to UR and have no or only very limited knowledge of German, we recommend participation in our pre-semester intensive language course (ILC), which takes place 5 weeks before the start of the regular semester. It includes 120 hours of German tuition as well as campus and city orientation and extracurricular activities. Visit our website (link and QR code at the end of this leaflet) to find out more.

Overview Winter Semester

Course Title	ECTS	Subject Area / Degree Program	Level *	Language
Natural Language Engineering I	6	Computer Science + Data Science	Bachelor	English
Understanding Information Behaviour	6	Computer Science + Data Science	Bachelor	English
Connector Genome Sequencing	6	Computer Science + Data Science	Bachelor	English
Complexity Theory	6	Computer Science + Data Science	Bachelor	English
Genomics & Bioinformatics	6	Computer Science + Data Science	Bachelor	English
Scientific Writing	2	Computer Science + Data Science	Bachelor	English
Data March (4 weeks block course in March)	8	Computer Science + Data Science	Bachelor	English
Developer Skills	3	Computer Science + Data Science	Bachelor	English
Data Science 2 (Inference)	6	Computer Science + Data Science	Bachelor	English
Data Science 3 (Modelling)	6	Computer Science + Data Science	Bachelor	English
Digital Image Processing I	6	Computer Science + Data Science	Bachelor	English
Self-Placed Research	12	Computer Science + Data Science	Bachelor	English

The courses listed here are the courses taught in English on a regular basis. Furthermore, each semester additional courses are offered where topics vary from semester to semester. These additional courses will be listed about 8-10 weeks prior to the semester in the course catalog.

Course Descriptions Winter Semester

Natural Language Engineering I

6 ECTS Method of Assessment: written exam

Everybody talks about ChatGPT, Large Language Models etc. but to understand how this all works, we will need to explore the basic foundations of natural language processing. The module will explore core concepts with a particular angle on practical use cases. Topics that will be covered will include (but are not be limited to): Linguistic foundations, Pipeline architecture in NLE, Regular expressions and automata, Text normalization, Statistical language modelling, Part-of-speech tagging, Text classification, Vector semantics. The textbook will be Jurafsky & Martin's "Speech and Language Processing" (2024) that is available at https://web.stanford.edu/~jurafsky/slp3/

Understanding Information Behaviour

6 ECTS Method of Assessment: report

In this course, students will work in groups to identify and answer a research question empirically. The projects will involve understanding how people perceive health information they find on the internet or via large language models. Students will learn and use advanced methods of data collection and analysis. After successfully completing this module, students will be able to:
* Evaluate others' approaches to data collection and analysis in terms of adequacy,
* collect data sets independently,
* Justify the suitability of descriptive, inferential and exploratory statistical methods in a manner appropriate to the research problem,
* Describe, explore and analyse data sets using statistical software.

Connector Genome Sequencing

6 ECTS Method of Assessment: oral or written exam

This module links data science with genome sequencing. The module covers next generation sequencing (NGS) technologies as well as algorithms for analyzing large NGS data sets. It addresses read alignment, detection of sequence variants, and RNA-Seq analysis, including single-cell-based scRNA-Seq analysis. The algorithms learned are used to examine genomic data sets in the accompanying exercise.

Complexity Theory

6 ECTS Method of Assessment: written exam

This module gives an introduction to computational complexity theory, the subfield of theoretical computer science that aims at proving lower bounds on the resources (time, memory, randomness, communication) required for solving computational problems. It is aimed at students of mathematics and computer science who are interested in understanding the limits of efficient computation. The course is self-contained. All preliminaries for students from different backgrounds will be included. Concrete topics in this course include:

- Time and space hierarchy theorems via diagonalization
- NP-completeness and the Cook-Levin theorem
- Space complexity (L, NL, PSPACE)
- The polynomial-time hierarchy and its complete problems
- Communication complexity
- Circuit complexity
- Randomness and derandomization
- Algebraic models of computation

Geonomics & Bioinformatics

6 ECTS Method of Assessment: exam

Everybody talks about ChatGPT, Large Language Models etc. but to understand how this all works, we will need to explore the basic foundations of natural language processing. The module will explore core concepts with a particular angle on practical use cases. Topics that will be covered will include (but are not be limited to): Linguistic foundations, Pipeline architecture in NLE, Regular expressions and automata, Text normalization, Statistical language modelling, Part-of-speech tagging, Text classification, Vector semantics. The textbook will be Jurafsky & Martin's "Speech and Language Processing" (2024) that is available at https://web.stanford.edu/~jurafsky/slp3/

Scientific Writing

2 ECTS Method of Assessment: exam

This course focuses on developing clear and effective scientific writing skills, specifically tailored for students in computer science and data science. You will learn how to structure research papers, present complex ideas with clarity, and craft compelling narratives around data and algorithms. Whether writing reports, academic papers, or research proposals, this course will help you communicate your ideas with precision and impact.

Data March

8 ECTS Method of Assessment: exam

Important information: **This course is taught as an intensive block course for four weeks prior to the regular start of the semester every March**. Interested students should know that this course cannot be combined with the intensive language course offered in March.

This full day block course provides a comprehensive introduction to the field of data science, designed for beginners. In many practical examples, you will see how three fundamental ways of thinking: thinking like a programmer, thinking like analyst and thinking like a researcher need to come together to address modern data science challenges. Through hands-on projects, you'll learn how to use Python to analyze real-world datasets, develop meaningful insights, and communicate your findings. Whether you're new to data science or looking to strengthen your foundation, this course equips you with essential skills to work with data effectively.

Developer Skills

3 ECTS Method of Assessment: exercises or exam

This hands-on course is taught by a group of FIDS (Faculty of Informatics and Data Sciecne) PhD students and Postdocs. Here you will learn the basic skills that you need to become a software developer. Master the command line, learn using git for version control, and improve your development workflow with efficient use of text editors and debugging. Each lecture comprises interactive labs and exercises to help you apply the concepts in a practical setting.

Data Science 2 (Inference)

6 ECTS Method of Assessment: written exam

This course focuses on the theoretical foundations of statistical inference and discusses the core topcis estimation and hypothesis testing. In the context of estimation topics such as exponential families, maximum likelihood, Fisher information and Bayesian approaches will be discussed. With respect to hypothesis testing core topics include confidence and credible intervals, likelihood-ratio tests and multiple testing.

Data Science 3 (Modelling)

6 ECTS Method of Assessment: written exam

Using both frequentist and Bayesian approaches generalized linear models which link continuous or discrete random variables to one or more explanatory variable will be discussed and their application in a range of application areas illustrated. Hierarchical models and mixed models will be introduced and extensions to non-linear models outlined.

Digital Image Processing I

6 ECTS Method of Assessment: written or oral exam

The module introduces the basics of digital image processing.
Contents:

- Image as an information carrier: Introduction to the methodology, technology and applications of digital image processing
- Imaging: human eye, cameras, other sensors and imaging geometry
- Image preprocessing: Grid and interpolation methods, homogeneous and inhomogeneous point operations
- Filtering: 2D Fourier transformation, FIR filters and nonlinear filters, feature extraction: edge detection, gradient and Laplace filters
- Segmentation: point-based, region-based, contour-based, model-based, and using neural networks
- Registration: point registration, surface registration, elastic registration
- Visualization of 3D image data: indirect and direct volume rendering

Self-paced Research

12 ECTS Method of Assessment: report

In this module, you will learn to conduct independent scientific research in data science. Working in teams of 3-4, you will tackle a research question over the course of the semester, developing and adjusting project plans as you go. You will meet regularly with a mentor for feedback and present your progress twice per semester to your peers and mentors. Through hands-on projects focused on current data science topics, you will gain skills in project planning, documentation, and scientific communication.

Overview Summer Semester

Course Title	ECTS	Subject Area/ Degree Program	Level *	Language
Natural Language Engineering II	6	Computer Science + Data Science	Bachelor	English
Introduction to Information Retrieval	6	Computer Science + Data Science	Bachelor	English
Computational Oncology	6	Computer Science + Data Science	Bachelor	English
Data Science 1 - Probability	6	Computer Science + Data Science	Bachelor	English
Computational Immunology	6	Computer Science + Data Science	Bachelor	English
Connector Clinical Trials	6	Computer Science + Data Science	Bachelor	English
Algorithmic Bioinformatics	6	Computer Science + Data Science	Bachelor	English
Machine Learning	10	Computer Science + Data Science	Bachelor	English
Self-Placed Research	12	Computer Science + Data Science	Bachelor	English
AI Methods & Applications	6	Computer Science + Data Science	Bachelor	English

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Natural Language Engineering II

6 ECTS Method of Assessment: project work

The module will look at advanced concepts of natural language processing with a particular angle on practical use cases. Topics that will be covered will include (but are not limited to): Information extraction, question-answering systems, dialogue systems and chatbots, text summaries, recent advances in neural approaches to natural language engineering. The textbook will be Jurafsky & Martin's "Speech and Language Processing" (2024) that is available at https://web.stanford.edu/~jurafsky/slp3/

Introduction to Information Retrieval

6 ECTS Method of Assessment: written exam

The module will lay the foundations of Information Retrieval (IR) both from a technical as well as a user perspective. Information Retrieval (or search engine technology) has been around for many decades but only the emergence of the Web has turned it into a key technology that touches every angle of industry and beyond. Topics that will be covered will include (but are not limited to): the IR processing pipeline, indexing, IR models, evaluation, foundations of Web search, log analysis, professional search, enterprise search,RAG, IR applications.

Computational Oncology

6 ECTS Method of Assessment: exam

This course introduces you to the core concepts of modern cancer research and how data science is shaping the future of oncology. You will learn how to develop data-driven methods to address current challenges in cancer research. Additionally, we will explore the foundations of personalized medicine, where data science helps tailor treatments to individual patients based on their unique genetic makeup. The course will provide you with an understanding of how computational approaches are transforming cancer diagnosis, prognosis, and therapy.

Data Science 1 – Probability

6 ECTS Method of Assessment: exam

In both natural and human-made environments, there are many processes where we cannot predict with certainty what is going to happen. However, often we can analyze how probable different outcomes are. This course introduces probability theory, the mathematical foundation for such analyses. We will introduce fundamental theory including random variables, distributions, and expectations, learn about famous theorems such as the law of large numbers or the central limit theorem, and also go into topics such as Markov chains and statistical inference. This course is not only a theoretical introduction but also involves a lot of practical examples and programming exercises. See the online textbook: https://prob-book.erhard-lab.de

Computational Immunology

6 ECTS Method of Assessment: exam

The immune system is one of the most complex systems evolution brought to existence. Very recent technological developments have made it possible to generate massive amounts of data about immune processes allowing us now to get a glimpse into its full complexity. These new technologies are also responsible for immunology (and many other branches of the life sciences) to more and more become a data science. In this course, we will introduce various general data science methods such as clustering,

dimensionality reduction, and data integration techniques, with examples from immunological research. A strong focus will be on the practical implementation and application of all methods.

Connector Clinical Trials

6 ECTS Method of Assessment: written exam

Clinical trials are carefully planned experiments on humans which aim to establish the safety and efficacy of a medicinal product. This course introduces the general context of clinical trials and the fundamental statistical principles that are used in such studies. Specific topics such as ethics of trials, superiority, non-inferiority or equivalence of treatments will be discussed and sample size determination considered.

Algorithmic Bioinformatics

6 ECTS Method of Assessment: exam

This module introduces elegant algorithmic concepts and data structures underlying many current bioinformatics analysis tools. It covers a range of sequence analysis algorithms that help to piece together hundreds of millions of DNA fragments in short time. It also introduces fundamental concepts in genetics, a basic understanding of DNA sequencing technologies, and databases holding molecular data. By the end of the course, you will be able to adapt existing and develop novel algorithms for various types of problems in bioinformatics, and to effectively interact with biologists, experimentalists, and clinicians in the interpretation of biomedical data.

Machine Learning

10 ECTS Method of Assessment: written exam

This module serves as an introduction to the general concepts of supervised learning for classification and regression problems. Various approaches for both tasks are presented, starting with simple approaches, such as linear regression and decision trees, through more complex approaches, such as kernel methods and tree ensembles, to an introduction to deep learning.In addition, unsupervised learning approaches are discussed, such as principal component analysis, clustering approaches and matrix factorization methods. An important focus is on model evaluation and model selection.

AI Methods & Applications

6 ECTS Method of Assessment: midterm tests and written exam

Upon completion of this module, students will have gained an in-depth understanding of fundamental methods in artificial intelligence (AI) and their application in various contexts. They will be able to assess the benefits of different AI-based approaches and develop the skills needed to technically implement theoretical concepts in relevant use cases. Students will also understand the role of AI applications in business value creation and will explore specific challenges, as well as the economic and technical trade-offs, in selected application contexts. The core topics covered include AI lifecycle management, model overfitting, algorithmic pricing, reinforcement learning, and an introduction to large language models.

Self-paced Research

12 ECTS Method of Assessment: report

In this module, you will learn to conduct independent scientific research in data science. Working in teams of 3-4, you will tackle a research question over the course of the semester, developing and adjusting project plans as you go. You will meet regularly with a mentor for feedback and present your progress twice per semester to your peers and mentors. Through hands-on projects focused on current data science topics, you will gain skills in project planning, documentation, and scientific communication.

Further information:

Information on all courses can be found in the **Course Catalog:**

https://www.uni-regensburg.de/ur-international/incomings/exchange-programs/course-selection/index.html

For more information on German language courses, housing, insurance, orientation programs, etc., Please see our **orientation guide** for incoming students

https://www.uni-regensburg.de/ur-international/incomings/exchange-programs/index.html

Contact:

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UR International homepage:
https://www.uni-regensburg.de/international/startseite/index.html (German version)
https://www.uni-regensburg.de/ur-international/orientation-page/index.html (English version)

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