University of Bremen

– Faculty 3 –

Courses

Winter Semester 2023/2024

M.Sc. Industrial Mathematics and Data Analysis

M.Sc. Mathematics

M.Sc. Mathematik

M.Sc. Technomathematik

September 2023

This brochure summarizes the courses and lectures for the Master's Industrial Mathematics and Data Analysis, Mathematics, Mathematik (German-language), and Technomathematik (German-language) for the upcoming winter semester 2023/2024. Further information can be found in the Course Catalog of the University of Bremen. There you will find, among other things, the language, the assignments to the individual modules, and the course code. The latter one can also be used to find a course in Stud.IP.

As you can see in the Course Catalog, all courses are in general assigned with an area of focus or specialization. This can also be found for all courses via *Fields of study* in Stud.IP. For the M.Sc. Industrial Mathematics and Data Analysis, these are Data Analysis and Industrial Mathematics. For the M.Sc. Mathematics and the M.Sc. Mathematik, these are Algebra, Analysis, Numerical Analysis, and Statistics/Stochastics.

At this point we would like to refer to the Offers for International Students as well as to Living on Campus for answers regarding living, housing, financial help, and scholarships.

Contact

Academic Advisory Office - Mathematics

Place to go for questions on study programs, planning, recognition of credits and exam results, study abroad, and examination regulations. Also responsible for the design of this brochure.

Lars Siemer
Room / Number: MZH Building / 1300
+49 (0) 421 218 63533
szmathe@uni-bremen.de

www.szmathe.uni-bremen.de

Contents

Lectures

Seminars

Alphabetic order and the lecturers are responsible for the content of their descriptions

Algebraic Topology

Course Code: 03-M-SP-26

Prof. Dr. Dmitry Feichtner-Kozlov

Contact: dfk@math.uni-bremen.de

Course Description

This lecture will introduce the basics of algebraic topology. Background in algebra is required and a previous course in topology, while not a strict requirement, will be helpful. Starting from this, we will introduce homology groups in various settings. Simplicial homology will be the main subject, but also singular homology will be mentioned. We will also use this course as a platform to look into the basics of category theory and the first concepts of homological algebra. Further information, such as literature suggestions and details on course work and exam will be provided on Stud.IP.

Algorithms and Uncertainty

Course Code: 03-IMAT-AU

Prof. Dr. Nicole Megow, Dr. Felix Hommelsheim

Contact: nmegow@uni-bremen.de, fhommels@uni-bremen.de

Description

A key assumption of most powerful optimization methods is that all the input data is fully accessible at any time. However, from the point of view of many real-world applications (e.g., in logistics, production or project planning, cloud computing, etc.) this assumption is simply not true. Large data centers allocate resources to tasks without knowledge of exact execution times or energy requirements; transit times in road networks are often uncertain and depend on weather, traffic or accidents; in other applications, parameters such as bandwidth, customer demands or energy consumption are highly fluctuating. The current trend of data collection and data-driven applications often amplifies this phenomenon. As the amount of available data is increasing tremendously due to internet technology, cloud systems and sharing markets, modern algorithms are expected to be highly adaptive and learn and benefit from the dynamically changing mass of data.

The class "Algorithms and Uncertainty" will teach the most common frameworks of modeling uncertainty in the input data and discusses different methods on how to design and analyze efficient algorithms in these different models.

Specifically, we will cover the theory of **online optimization**, where initially unknown input data is revealed incrementally and needs to be processed immediately, before the next piece of information arrives. This model is best suited for analyzing critical networking and scheduling systems where devices and algorithms must perform well even in the worst-case scenario.

In the cases where previous history can be used to model the upcoming data, we often employ **robust optimization** or **stochastic optimization**. In robust optimization, the aim is to optimize the worst-case of all possible realizations of the input data. Hence, this model is rather conservative. In stochastic optimization however, the algorithms work with the assumption that data is drawn from some probability distribution known ahead of time and typically the goal is to optimize the expected value.

We also discuss modern, new lines of research going beyond the traditional models. Nowadays, another source of information is often available: machine learning algorithms can generate predictions which are accurate most of the time. However, there is no guarantee on the quality of the prediction, as the current instance may not be covered by the training set. This statement motivated a very recent research domain that will be covered in this course: how to use **error-prone predictions** in order to improve guaranteed algorithms.

Format and Examination

The course aims mostly at **Master's** students, although **Bachelor's students in higher semesters** are also very welcome. We teach the course with **4 hours per week** (**4 SWS** for **6 CP**), where roughly every other week one class will be an interactive exercise session.
There is the possibility to further extend the content of the course as well as the credits (**+3 CP**) by a seminar-style contribution (individual study of a recent research article and presentation to the rest of the class).

Time + Room: tbd

Examination: The examination will be by individual oral exam. As admission to the oral exam it is mandatory to present solutions in the exercise session at least twice during the term.

Prerequisites

Having heard an introductory course to discrete algorithms and their mathematical analysis (e.g. "Algorithmische Diskrete Mathematik", "Algorithmentheorie") is beneficial but it is not a requirement.

Literature

- Borodin and El-Yaniv: Online Computation and Competitive Analysis, Cambridge University Press, 1998
- A Ben-Tal, L El Ghaoui, A Nemirovski: Robust Optimization, Princeton University Press, 2009
- Most of the presented material is more recent and we will point to the corresponding research articles.

Basics of Mathematical Statistics

(Statistics I)

Course Code: 03-M-SP-2

Prof. Dr. Thorsten Dickhaus

Contact: dickhaus@uni-bremen.de

Course Description

In the course „Statistics I“, parametric statistical models and corresponding statistical methods will be introduced. In this, we pursue a general decision-theoretic approach, from which we will derive the different sub-areas of inferential statistics (point estimation, confidence estimation, hypothesis testing, etc). In prototypical model classes, we will characterize optimal decision rules.

The specific topics of the course are:

- Decision making under uncertainty, statistical models
- Loss and risk, optimal decision rules
- Point estimation
- Confidence estimation
- Hypothesis tests
- Inferential likelihood theory
- Exponential families
- Bayesian statistics
- The statistics software `R`

The course „Statistics I“ is the entry point for a specialization in the area of (mathematical) statistics. Statistical methods are of utmost importance for all quantitative sciences, and they provide the basis for data science.

Course Prerequisites

No formal prerequisites, but solid knowledge in measure-theoretic probability theory is required to understand the material.

Times and Formalities

The course consists of four hours of lecture plus two hours exercise class per week.

Upon successful completion, 9 ECTS credit points will be awarded for this course.

Solutions to exercise sheets have to be handed in on a weekly basis.
The final examination will be in written form.

List of Literature

We will mainly follow the exposition in the following textbook.

Vladimir Spokoiny, Thorsten Dickhaus (2015):
Basics of Modern Mathematical Statistics.
Springer Texts in Statistics, ISBN 978-3-642-39908-4

The book will be provided (in parts) electronically via Stud.IP.

In addition, a list with further literature will be provided.

Finite Elements for Contact Problems

Course Code: 03-M-SP-27

Prof. Dr. Andreas Rademacher

Contact: arademac@uni-bremen.de

Course Description

The lecture is divided into three parts: In the first part, the basics from the area of convex analysis and functional analysis, which are necessary to describe contact problems mathematically, are worked out. The main part of the lecture then consists of the consideration of simplified Signorini problems, which describe the contact of an elastic membrane with a rigid obstacle on the boundary. Based on the analytical formulation, four different approaches to their discretisation including the corresponding numerical solution algorithms are presented and analysed. The lecture concludes with an outlook on more complex contact problems, such as the contact of several elastic bodies or the consideration of friction effects.

Course Prerequisites

Basic knowledge of Sobolev spaces and the finite element method is assumed, as taught e.g. in the lecture "Numerical Methods for PDEs".

Times and Formalities

- Weekly homework
- Active participation in the exercises
- Oral exam

List of Literature

- Z. Dostal, T. Kozubek, M. Sadowska, V. Vondrak: Scalable Algorithms for Contact Problems. Springer-Verlag, 2016.
- T. Laursen: Computational Contact and Impact Mechanics: Fundamentals of Modeling Interfacial Phenomena in Nonlinear Finite Element Analysis. Springer, Heidelberg, 2002.

- N. Kikuchi, J.T. Oden: Contact problems in elasticity: A study of variational inequalities and finite element methods. SIAM Studies in Applied Mathematics, SIAM, 1988.
- B. Wohlmuth: Variationally consistent discretization schemes and numerical algorithms for contact problems. Acta Numerica 20, 569–734, 2011.
- P. Wriggers: Computational Contact Mechanics. Wiley, 2002.

Introduction to Nonlinear Optimization, Optimal Control and Optimal Feedback Control

Course Code: 03-M-SP-31

Prof. Dr. Christof Büskens

Contact: bueskens@uni-bremen.de

Course Description

The famous mathematician Leonhard Euler once said "Nothing takes place in the world whose meaning is not that of some maximum or minimum", or in other words, optimization takes place everywhere. Electricity takes the path of lowest impedance, light takes the path of shortest time, physical systems tend to a state of minimum energy,. . . . And humans also optimize (or at least try to): Train journeys are optimally coordinated, workers are allocated in the best possible way, traffic flows are maximized, companies maximize their profit and insurances try to minimize damage. In mathematics, optimization is a key technology to connect science with application. Uniquely solvable systems of equations are rather a special case. Usually, systems are overdetermined, and solutions are obtained by optimization methods, e. g. to determine digital twins, or they are underdetermined, and the remaining degrees of freedom are used to optimize a higher-order performance measure. In this lecture we will cover some of the basic principles of optimization in the static as well in the dynamic case.

Area of Focus or Specialization:

- M.Sc. Industrial Mathematics and Data Analysis: Industrial Mathematics
- M.Sc. Mathematics: Numerical Analysis

Course Prerequisites

There are no formal prerequisites but basic knowledge from a mathematical Bachelor's degree is necessary, in particular the knowledge of the modules Numerical Analysis 1, Numerical Analysis 2 is strongly recommended. Basic knowledge in programming skills and the use of mathematical software can be beneficial.

Times and Formalities

The lecture takes place in NEOS-Building. The weekly exercises also include programming exercises (e.g. with MATLAB or Python). The exercises are submitted and corrected digitally.

List of Literature

Will be announced in the lecture.

Introduction to Robust Control

Course Code: 03-M-SP-30

Dr. Chathura Wanigasekara

Contact: chathura@uni-bremen.de

Course Description

In this course Robust control is introduced. Robust control is an approach to design controllers to deal with uncertainty. The aim is to achieve robust performance (or stability) in the presence of bounded modelling errors.

Course Prerequisites

Basic knowledge of control systems; Basic knowledge of optimisation

List of Literature

- B. Francis, A course in H_∞ control theory, Springer-Verlag, 1987.
- J. Doyle, B. Francis, A. Tannenbaum, Feedback Control Theory, Macmillan Publishing Company, 1990.
- S. Skogestad, I. Postlethwaite, Multivariable Feedback Control, Analysis and Design, John Wiley & Sons, 1996.
- K. Zhou, J.C. Doyle, K. Glover, Robust and Optimal Control, Prentice-Hall, 1996.
- G.E. Dullerud, F. Paganini, A Course in Robust Control, Springer-Verlag, 1999.
- S. P. Bhattacharya, H. Chapellat, L. H. Keel. Robust Control-The Parametric Approach, Prentice Hall, 2000.

Mathematical Methods for Data Analysis and Image Processing

Course Code: 03-M-MDAIP-1

Prof. Dr. Dirk Lorenz

Contact: d.lorenz@uni-bremen.de

Course Description

This lecture covers several basic methods for standard tasks in data analysis and image processing. A non-exclusive and non-exhaustive list of methods: histograms, dimension reduction, clustering, filters, frequency analysis, morphological methods... We will develop the mathematical theory that underlies these methods which is the basis for thorough understanding and proper execution of the method. Moreover, we will deal with the practical implementation of the methods and apply them to solve problems such as image denoising, image deblurring, or music identification.
This lecture should enable you to take a deeper dive into image and data analysis and prepares you to follow recent developments in the field. If you want to understand the inner working of image compression with JPEG or music recognition with tools like Shazam, come to this lecture!

Course Prerequisites

Analysis 1-2 (preferably also Analysis 3), Linear Algebra 1-2, Numerics 1 and the ability to implement mathematical methods in software (e.g. Python or MATLAB) are needed. Some background in Functional Analysis would be helpful.

List of Literature

- Mathematical Image Processing; Kristian Bredies and Dirk Lorenz, Birkhäuser, 2018, https://link.springer.com/book/10.1007/978-3-030-01458-2

- Mathematics for Machine Learning; Marc Peter Deisenroth, A. Aldo Faisal, and, Cheng Soon Ong, Cambridge University Press, 2020, https://mml-book.com.

Numerical Methods for Partial Differential Equations

Course Code: 03-M-NPDE-1

Prof. Dr. Alfred Schmidt

Contact: alfred.schmidt@uni-bremen.de

Course Description

Partial differential equations are a main component in the modelling of physical, chemical or biological phenomena in several spatial dimensions or in space and time. They also often occur in mathematical problems in geometry or calculus of variations. The lecture deals with the discretisation of partial differential equations and the estimation of the error between continuous and discrete solution. In particular, the finite element method is introduced and investigated, with special consideration of modern adaptive algorithms. We will first discuss the application of the method to stationary elliptic problems. Later also time-dependent problems will be considered. The connection of theory, numerical analysis and implementation is particularly important. Facts from the theory of partial differential equations are usually only quoted. Based on special application-oriented chapters of the lecture, the numerical algorithms are to be implemented in programming tasks under guidance.

Course Prerequisites

You need a good knowledge of analysis, linear algebra, and numerical mathematics. Some knowledge of functional analysis is advantageous. Programming skills in Octave/Matlab are needed for the practical exercises.
A list of desirable previous knowledge is provided in Stud.IP.

Times and Formalities

There are two lectures and one exercise session per week. Every week an exercise sheet is published with theoretical and, if applicable, practical tasks. For the award of the course credit, 50% of the possible points must be achieved in both theoretical and practical exercises. After the lecture period, oral examinations take place on dates to be agreed upon.

List of Literature

Online you find several Lecture Notes on Numerical Methods for PDEs, which contain most of the subjects which will be presented in the module, for example:

- https://www-users.cse.umn.edu/~arnold/8445.f11/notes.pdf
- https://www.wias-berlin.de/people/john/LEHRE/NUM_PDE_FUB/num_pde_fub.pdf
- https://ocw.mit.edu/courses/16-920j-numerical-methods-for-partial-differential-equations-sma-5212-spring-2003/pages/lecture-notes/

Algebra

Course Code: 03-M-AC-15

Prof. Dr. Eva-Maria Feichtner

Kontakt: emf@math.uni-bremen.de

Veranstaltungsbeschreibung

Das Pro- bzw. Seminar wird sich ausgewählten Themen der Gruppentheorie widmen.

Voraussetzungen

Solide Kenntnisse der Algebra.

Ablauf, Format und Prüfungsform

Das Pro- bzw. Seminar wird als Blockseminar im Anschluss an die Vorlesung "Algebra" in der vorlesungsfreien Zeit stattfinden. Erwartet werden ein Seminarvortrag (60 min) mit Diskussion sowie eine schriftliche Ausarbeitung. Bei Interesse und entsprechend anspruchsvoller Themenwahl kann die Veranstaltung auch als Seminar belegt werden.
Ein Vorbesprechungstermin (voraussichtlich im Januar) wird rechtzeitig auf Stud.IP angekündigt.

Approximation Methods in Probability and Statistics

Course Code: 03-M-AC-16

Prof. Dr. Thorsten Dickhaus

Contact: dickhaus@uni-bremen.de

Course Description

This is a seminar in the specialization area „Stochastics / Statistics“, dealing with (asymptotic) approximations of probability distributions and random variables.

The specific topics of the seminar are:

- Empirical processes, Brownian bridges
- Strong approximations (Hungarian construction)
- Stein's method
- Edgeworth and saddlepoint expansions
- Miscellaneous further topics

Course Prerequisites

No formal prerequisites, but solid knowledge in measure-theoretic probability theory is required to understand the material.

Times and Formalities

The seminar consists of one session (of 90 minutes length) per week.

Upon successful completion, three to six ECTS credit points will be awarded for this seminar. The exact number of credit points depends on the study program in which the candidates are enrolled.

Students are expected to work themselves into a topic, to give a talk and to write a term paper on that topic, and to participate actively in the discussions of the other presentations.

List of Literature

A list of relevant literature will be provided electronically via Stud.IP.

Convex Analysis

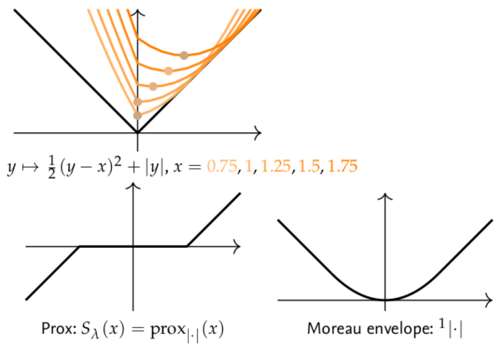
Course Code: 03-M-AC-19

Prof. Dr. Dirk Lorenz

Kontakt: Dozent:in@uni-bremen.de

Course Description

Convex analysis deals with convex sets in $\mathbb{R}^d$ and convex functions from $\mathbb{R}^d$ to $\mathbb{R}$. The notion of convexity (for sets: Lines connecting points inside a set are inside the set), may sound unspectacular at first sight, but it has numerous consequences. A very far-reaching consequence is that besides the definition from within, there is also an equivalent description from without: A set is convex if it is the intersection of all half-spaces which contain the set.
In this seminar we will learn topics of convex calculus, such as separation theorems, (sub)differentiability of convex functions, convex conjugation, proximal mappings. If interested, topics on convex optimization may also be included.



Course Prerequisites (if required)

Analysis 1 and 2, Lineare Algebra 1

Times and Formalities

Talks by students and the lecturer, written report

List of Literature

- Convex Analysis, R. Tyrrell Rockafellar, Princeton University Press, 1970

- Convex Analysis, Dirk Lorenz, Lecture Notes, https://www.tu-braunschweig.de/iaa/personal/lorenz/lehre/skripte

Ergodic Theory

Course Code: 03-M-AC-18

Prof. Dr. Anke Pohl

Contact: apohl@uni-bremen.de

Course Description

Ergodic Theory is a research field within dynamical systems theory which focuses on the investigation of the long-term behavior of dynamical systems in regard to probabilistic and measure-theoretic aspects. This field originates in statistical physics. Nowadays the concepts and methods of Ergodic Theory are applied in many areas of mathematics. In the last few years, it became clear that Ergodic Theory is useful as well in the research field of data-driven dynamical system. In this seminar, we will delve into some parts of these developments. The precise topic will be decided together with the participants; it is independent of the Reading Course/Seminar Analysis from Summer 2023. Depending on the number of participants, this seminar might be combined with the Reading Course Analysis (03-M-RC-ANA; topic: data-driven dynamical systems).

Course Prerequisites

Solid mathematical knowledge to the extent of a bachelor's degree in mathematics. Some background in Ergodic Theory or Functional Analysis or both. Of course, knowledge of both areas is better, but one is sufficient if one is willing to accept some results or ideas from the other field without detailed proofs. Choice of material and level of discussion of background material will be adapted to the previous knowledge of the participants.

Formalities

First meeting is Thursday, October 19, 2024, 12:15 - 01:45 p. m.(please check in Stud.IP for the room).

Further Information

Further and more detailed information will be communicated via Stud.IP. Please consider to register early to facilitate the organization.

Harmonic Analysis Techniques for Elliptic Operators

Course Code: 03-M-AC-17

Dr. Hendrik Vogt

Contact: hendrik.vogt@uni-bremen.de

Course Description

The seminar is based on the so-called "27th Internet Seminar 2023/24". The homepage of the seminar will soon be available under the following link:

https://www.math.kit.edu/iana3/seite/isem/

On the homepage, new material will be provided each week, starting mid October. This material shall be presented by the participants.

The seminar is devoted to the treatment of elliptic operators $L = -\operatorname{div}(A\nabla)$ with techniques form harmonic analysis and functional calculus.

A continuation in the summer semester is possible: there will be a project phase where you can work in small international groups of 3–4 students and a workshop in Luminy (June 17 to June 21, 2024) where participants meet together with leading experts in the field.

Course Prerequisites

Basic knowledge in functional analysis is highly recommended (bounded operators, foundations of Hilbert spaces, Fourier transform), as well as foundations in complex analysis.

Times and Formalities

Apart from registering on Stud.IP, please also register via the homepage of the 27th Internet Seminar to get access to the seminar material.

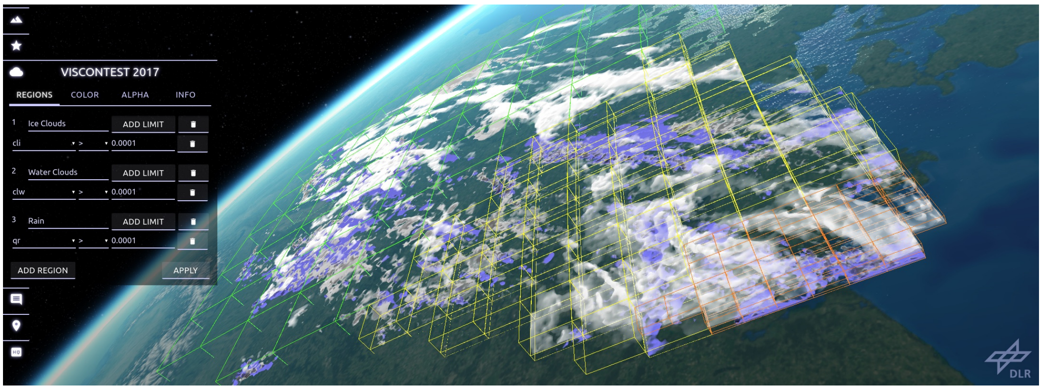
High-Performance Visualization

Selected publications from the field of visualization of large scientific datasets

Course Code: 03-M-AC-2

Prof. Dr. Andreas Gerndt

Contact: gerndt@uni-bremen.de



Course Description

The seminar deals with the mathematical basics of scientific visualization and covers methods for parallel post-processing of large scientific datasets. A wide variety of scientific applications make use of such data. On the one hand, they are generated by simulations on high-performance computers (e.g., to support climate research or to predict airflow around aircraft wings). But they can also be generated by measurements e.g. by Earth observation missions. In order to obtain meaningful information for visualization, these enormously large raw data must first be processed. For a subsequent explorative analysis, real-time interactive methods are needed, which in turn rely on highly parallel and efficient approaches. The seminar therefore addresses current trends in scientific visualization. Outstanding publications by leading scientists will be selected, covering topics ranging from multi-resolution extraction of topology features to parallel acceleration methods for volume rendering in virtual working environments.

Course Prerequisites

The seminar is open to students from the fields of mathematics, computer science or from other relevant domains (such as geosciences or aerodynamics). Previous participation in the lecture "High-Performance Visualization" would be helpful. However, this is not a prerequisite. Knowledge in Computer Graphics or High-Performance Computing (HPC) might also be helpful.

Times and Formalities

In the introductory session, selected publications from the field of scientific visualization will be presented. The students can then choose one of the papers. By Christmas, the underlying basic literature is to be researched. In the further course of the semester, the topic will then be prepared and a seminar paper of approximately 20 pages will be written. At the end of the semester, the papers will be presented. Depending on the number of participants, the presentations will take place in individual or block sessions. Students are expected to present the elaborated topics in 45-minute talks. The presentation and paper should preferably be in English. Seminar paper and presentation will be used for a performance evaluation. For questions and support, contact persons for the respective topics are available throughout the semester. The supervision will take place mainly online.

List of Literature

- A. C. Telea, "Data Visualization – Principles and Practice", 2. Edition, CRC Press, 2015
- E. W. Bethel, H. Childs, C. Hansen, "High Performance Visualization", CRC Press, 2013
- W. Schroeder, K. Martin, B. Lorensen, "The Visualization Toolkit", 4. Edition, Kitware, 2006
- C. Hansen, C. Johnson, "The Visualization Handbook", Elsevier Academic Press, 2005

Numerical Methods and Neural Networks for Partial Differential Equations

Course Code: 03-M-AC-20

Prof. Dr. Andreas Rademacher and Prof. Dr. Alfred Schmidt

Contact: arademac@uni-bremen.de, alfred.schmidt@uni-bremen.de

Course Description

Many models from applications lead to nonlinear partial differential equations or systems of partial differential equations (PDEs). Their solution as well as aspects of optimization typically demand for numerical methods.
In the winter term 2023/24 we will especially look on the one hand at finite element methods for models in engineering applications from milling and grinding processes, on the other hand at the application of machine learing methods and neural networks for the solution of PDEs.

Course Prerequisites

Advantageous will be a good knowledge of analysis and numerical methods, as well as some proficiency in numerical methods for partial differential equations, which is typically taught in the lectures of the same name. Especially, previous knowledge about mathematical aspects of *finite element methods* (FEM) and/or *neural networks* will be beneficial.

Times and Formalities

Successful conclusion of the seminar demands an oral presentation of about 60 minutes plus discussion and a written elaboration about the subject of the talk.
A preliminary discussion of available subjects will be offered in the first week of the lecture period, but subjects can be assigned later, too. Just get in touch with the organizers.

Modeling Project

Part 2

Course Code: 03-M-MP-2

Prof. Dr. Andreas Rademacher

Contact: arademac@uni-bremen.de

Course Description

Over the course of two semesters, the participants of the modeling project work in teams on a project in which they are supposed to use the mathematical knowledge they have already acquired in applications outside of mathematics. The project partners can be industrial companies or research institutes. The range of topics is determined by the offers of the project partners. This year we are looking forward to cooperation with these partners (in alphabetical order):

- Alfred-Wegener-Institute (AWI, Bremerhaven)
- Bosch
- Bruker Daltonics (Bremen)
- German Aerospace Center (DLR): Institute for the Protection of Maritime Infrastructures (Bremerhaven)
- KUKA Assembly & Test (Bremen)
- Sikora (Bremen)

Course Prerequisites

The modeling project is aimed at students in the Master's programme in Industrial Mathematics and Data Analysis. In limited exceptions, students in the Master's programme in Mathematics can also participate.

Times and Formalities

- Regular meetings
- Presentations by the participants on their topics and the current status of their work

The assessment will take place at the end of the modeling project (Part 2) in February 2024 on the basis of these submissions:

- Internal mathematical presentation and public user-oriented presentation
- Written elaboration (approx. 30 pages)
- Poster or comparable format, e.g. video, interactive software, demonstrator

Introduction to R

Course Code: 03-M-GS-7

Prof. Dr. Werner Brannath, Eike Voß

Contact: brannath@uni-bremen.de, evoss@uni-bremen.de

Course Description

The course focuses on the basics of R, including its core functions and syntax, so that students can gain a comprehensive understanding of the language. It is designed for students who have a fundamental understanding of programming and a basic understanding of statistics. No prior experience with R is required, making this course a great starting point for those looking to learn a new (statistical) programming language. Students will learn how to conduct descriptive and exploratory data analyses by engaging in hands-on activities and practice working with real-world data sets. This practical approach helps students see the real-world applications of R and provides a solid foundation for further study in data analysis and programming. Whether you are a beginner looking to get started with R or simply looking to refresh your skills, this course is designed to help you reach your goals.

Course Prerequisites

Fundamental understanding of programming and basic knowledge in statistics.

Times and Formalities

Friday 13:00-16:00.

List of Literature

- Introductory Statistics with R, P. Dalgaard, 2008
- R for Data Science, H. Wickham, 2017

Nachhaltige Methoden und Methoden für Nachhaltigkeit in Mathematik und Informatik

Ringvorlesung im Fachbereich 3

Course Code: 03-IBFW-NMIM

AG Nachhaltigkeit, Diren Senger et al.

Kontakt: diren@uni-bremen.de

Veranstaltungsbeschreibung

Nachhaltigkeit, besser gesagt nachhaltige Entwicklung, ist ein großes Ziel, das sich auch unsere Universität Bremen auf die Fahnen geschrieben hat. Damit dieses sich deutlicher in der Lehre unseres Fachbereiches widerspiegelt, wird es im WiSe 2023/2024 eine Ringvorlesung geben, in der verschiedene Forscherinnen und Forscher über Bezüge zwischen ihrer Arbeit und unterschiedlichen Aspekten der Nachhaltigkeit berichten – als Anstoß für Diskussionen mit vielen Menschen, die gleichfalls an der Konkretisierung der Nachhaltigkeitsziele mitarbeiten wollen. Aus dieser Initiative werden sich dann hoffentlich viele weitere Aktivitäten entwickeln, insbesondere weitere Lehrveranstaltungen in kommenden Semestern. Eingeladen sind alle Studierenden, Lehrenden und Forschenden mit Interesse an Nachhaltigkeitsthemen, ganz allgemein oder in einem spezielleren Sinn.

Es wird Präsentationen u.a. zu folgenden Themen geben:

- "‘Energieverbrauch in Machine-Learning-Verfahren, Biases in Machine-Learning-Trainingsdaten"’
- "‘Vom Kaffeeprütt zum Energieforschungshof Osterholz"’
- "‘Towards improvements in sustainability of Internet Infrastructure, Internet-based Applications, and the Internet of Things"’
- "‘Extreme value analysis of climate time series"’
- "‘Cyber-Physical Systems for Sustainability"’
- "‘Nachhaltige Bildung und Bildung für Nachhaltigkeit"’

Voraussetzungen

Interesse am großen Thema Nachhaltigkeit, seinen unterschiedlichen Aspekten und wie sich diese im FB 3 widerspiegeln – und weiterentwickeln können.

Ablauf, Format und Prüfungsform

Für alle Studiengänge im FB 03 – und offen für alle anderen.
Wöchentlich eine Präsentation, montags 16-18 Uhr.
Hybrid – live in der Uni und online via bbb.
2 CP (im Bereich "‘freie Wahl"’ bzw. "‘General Studies"’, unbenotet) durch das Beantworten von Quizfragen.

Starting Data Science using R

an integrated course with practicals and projects

Prof. Dr. Stephan Frickenhaus

Contact: sfricken@uni-bremen.de

Description of the course

The term "Data Science" has been used very often in recent years to frame modern data analysis methods as a discipline between mathematics, statistics and computer sciences, mainly for applications in data driven research [1]. This course provides insights into the practice of data science to a broader audience within the General Studies. The basis is real world example data and real research questions.
The course gives basics of programming in R, assuming that self teaching is practiced to fill gaps. Students are welcome to present own ideas, data and projects. The project may contain self teaching elements, e.g., by exploration of R-books, or R-forums on the internet to solve programming tasks to analyse a data set. Practicals in R will work also on synthetic data to illustrate methods' features, limitations and differences.
Real scientific data is provided by researchers from the Alfred Wegener Institute, Bremerhaven (example given in Fig. 1). Exploring data and preparing it for analyses will be trained, as well as automatized data processing for big/multiple data sets.

Schedule, Format and Exam

Probably we will work with the computers in MZH-0240, or, preferred, in a seminar room (with your own laptops) Wednesdays 14:00 c.t. - 16:00.
The course takes 2 SWS; it offers 3 EC. For successful participation I expect a project report as presentation or a method talk with demo on own or provided data. No grade is given.

Requirements

Your own laptop computer would be very useful for doing home and project work. Make shure you installed R from r-project.org and the free-of-charge desktop version of R-Studio from www.rstudio.com/products/rstudio/. This makes your R programming and data management much easier.

[1] see https://www.nsf.gov/cise/ac-data-science-report/CISEACDataScienceReport1.19.17.pdf

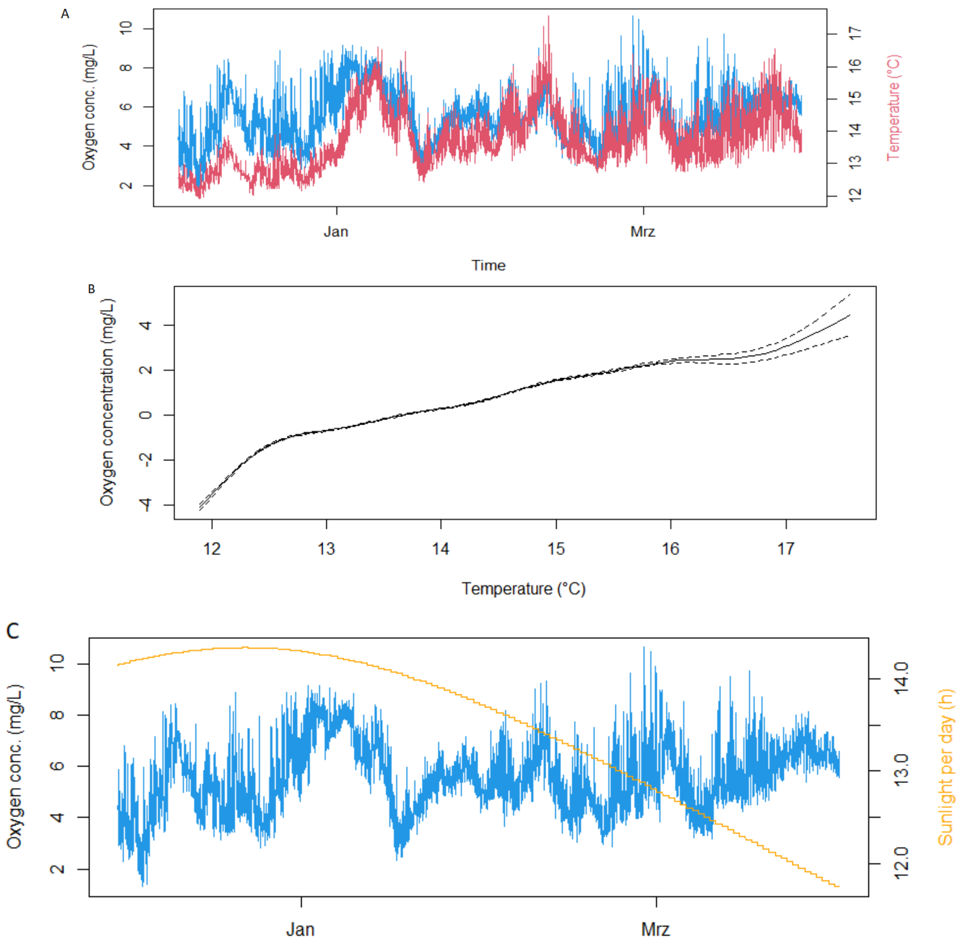


Figure 1: Example data from Valparaiso coastal observations summer 2015/2016, Chile; A: temperature and oxygen content data; B: Generalized additive model, C: computed Sunlight per day

Literature

- Garrett Grolemund, Hadley Wickham
  R for Data Science (2016), O'Reilly Media, Inc.
  ISBN: 9781491910399
  online at SUUB: https://suche.suub.uni-bremen.de/peid=B83772371