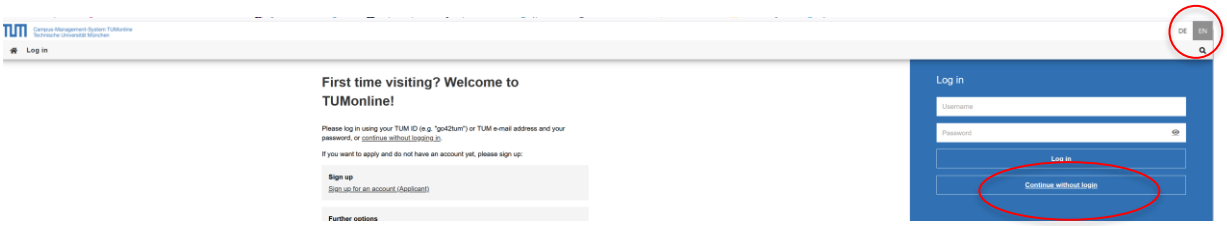
Guideline for Choosing Courses

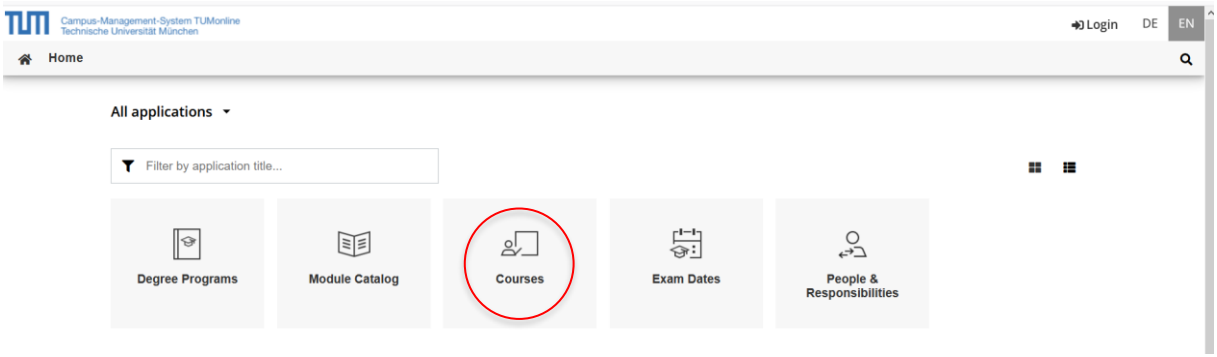
TUM School of Computation, Information and Technology - Mathematics
March 2023

1. How to use TUMonline – offered courses of a specific semester

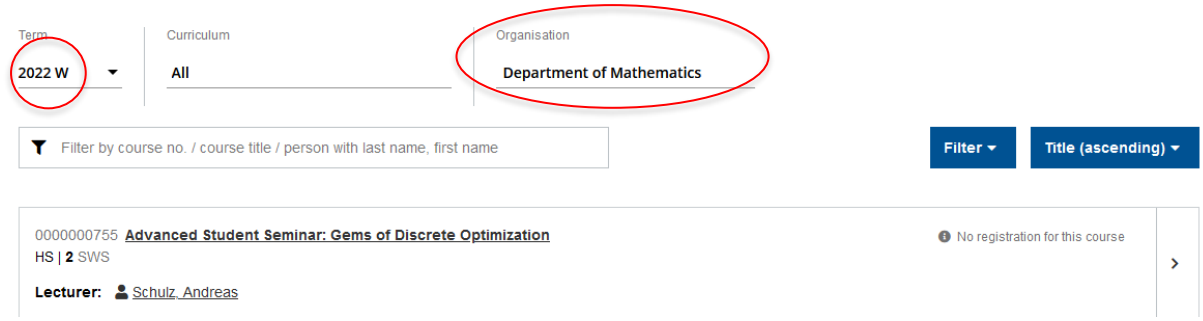
To find out about offered courses, see module descriptions or to sign up for lectures, exercises and exams, you will use www.campus.tum.de , our campus management system, also known as TUMonline.
This is how the start page looks like. At the top right corner, you can change the language to English if necessary. Continue without login.



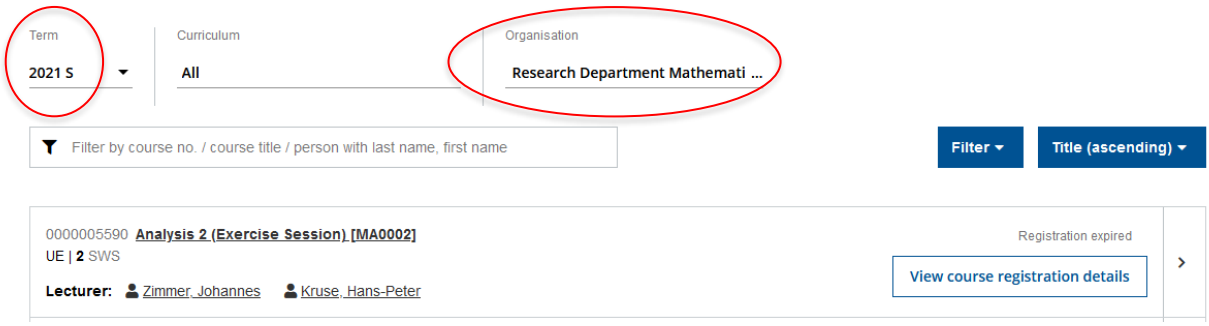
Now you see all the applications TUMonline offers:



If you want to know which courses in the Mathematics Department are **currently** being offered, please choose *Courses*. Under Organization you need to select *Department of Mathematics* to be able to see all offered *Courses* (*Lehrveranstaltungen*) in maths in the selected *Term (Semester)*:



In case you want to look up the offered courses of a semester **prior** to the winter semester 2022/23 please enter *Research Department Mathematics Centre* under Organisation. Otherwise no entries will be shown:



2. List of regularly offered courses

The following list is an overview of regularly offered **a)** graduate, **b)** advanced bachelor's/ foundation master's and **c)** undergraduate modules. Additionally, our department offers a lot of advanced special modules with different topics each semester. These special modules might be offered every year as well, but it is also possible that they are offered irregularly, every two years or even only one-time (see 3.). The regular workload per term at TUM is 30 ECTS (Credits).

The list of available courses is displayed in TUMonline only 4-6 weeks in before the semester starts.

The following classification is not mandatory, but just to be understood as an overview (orientated at the classification from the M.Sc. Mathematics). In general, the meaning of the alphanumerical ID for each course is as follows:

MA	Course offered by the mathematics department
0xxx	Basic and fundamental courses
1xxx	expired modules or only suitable for teaching degree students
2xxx	complementary and specialization modules
3xxx-4xxx	Advanced courses
5xxx	Specialized master's courses (mainly offered irregularly)
9xxx	Service lectures for other departments
CIT41xxx	Course offered by the mathematics department (after foundation of CIT in 2022)

Courses with ID 0xxx and 2xxx are mostly bachelor's modules and hence offered in German. The other modules are master's level courses where the language of instruction is mostly English. If you plan to attend German taught classes we recommend a minimum level of B2 in German.

Please note: You may choose your courses freely according to your personal interest, but please make sure you bring the recommended prerequisites (please see bullet points 3. and 4. below). Otherwise it will be challenging to pass the exam.

a) Graduate / Master's Courses

Analysis and PDE

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3080	Introduction to Nonlinear Dynamics	5	WiSe	English	2L+1E
MA3081	Dynamical Systems	9	SuSe	English	4L+2E

Algebra, Geometry

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3205	Differential Geometry - every 2 years only	9	WiSe	English	4L+2E
MA3203	Projective Geometry 1	9	WiSe/SuSe	English	4L+2E

Probability, Statistics and Financial Mathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3403	Generalized Linear Models	9	WiSe	English	4L+2E
MA3406	Insurance Mathematics 2	9	SuSe	English	4L+2E
MA3408	Financial Mathematics 2	9	SuSe	English	4L+2E
MA3442	Actuarial Risk Theory	5	SuSe	English	2L+1E
MA3703	Fixed Income Markets	5	WiSe	English	2L+1E
MA4405	Stochastic Analysis	9	SuSe	English	4L+2E
MA4406	Probability on Graphs	5	SuSe	English	2L+1E
MA4408	Markov Processes	9	SuSe	English	4L+2E

Every 2 years only					
MA4402	Computational Statistics	5	SuSe	English	2L+1E
MA5415	Quantitative Risk Management	5	SuSe	English	2L+1E

Numerics, Optimization and Biomathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3303	Numerical Methods of PDEs	9	SuSe	English	4L+2E
MA3602	Advanced Mathematical Biology	9	SuSe	English	4L+2E
MA4502	Combinatorial Optimization	5	SuSe	English	2L+1E
MA4503	Modern Methods in Nonlinear Optimization	5	SuSe	English	2L+1E
MA4512	Case Studies (Discrete Optimization)	7	SuSe	English	4L
MA4513	Case Studies (Nonlinear Optimization)	7	SuSe	English	4L
MA4306	Case Studies (Scientific Computing)	6	WiSe/SuSe	English	2L(+2E)

Every 2 years only					
MA4302	Computational Inverse Problems	6	SuSe	English	3L+1E

Machine Learning and Data Analysis

MA4800	Foundations of Data Analysis	8	SuSe	English	4L+2E

Every 2 years only, alternating					
MA4801	Mathematical Foundations of Machine Learning	6	SuSe	English	2L+2E
MA4802	Statistical Learning	6	SuSe	English	2L+2E
MA4803	Probabilistic Techniques and Algorithms in Data Analysis	6	WiSe	English	2L+2E
MA4804	Geometry and Topology for Data Analysis	6	WiSe	English	2L+2E

b) Advanced Bachelor's / Foundation Master's

Analysis and PDE

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3001	Functional Analysis	9	WiSe	English	4L+2E
MA3005	Partial Differential Equations	9	SuSe	English	4L+2E

Algebra, Geometry

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA5120	Algebra 2	9	WiSe	English	4L+2E

Probability, Statistics and Financial Mathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA2404	Markov Chains	5	SuSe	German	2L+1E
MA2409	Probability Theory	9	WiSe	English	4L+2E
MA3405	Insurance Mathematics 1	9	WiSe	English	4L+2E
MA3407	Financial Mathematics 1	9	WiSe	English	4L+2E

Numerics, Optimization and Biomathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA3301	Numerics of Differential Equations	9	WiSe	English	4L+2E
MA3503	Nonlinear Optimization	5	WiSe	English	2L+1E
MA3505	Integer Optimization	9	WiSe	English	4L+1E
MA3601	Mathematical Models in Biology	9	WiSe	English	4L+2E

c) Undergraduate / Bachelor's Courses

Analysis and PDE

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA0003	Analysis 3	9	WiSe	German	4L+2E
MA2006	Complex Analysis	5	SuSe	German	2L+1E

Algebra and Geometry

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA2010	Algebra	9	SuSe	German	5L+2E
MA2011	Geometry	9	SuSe	German	4L+4E

Probability, Statistics and Financial Mathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA0009	Introduction to Probability and Statistics	9	WiSe	German	4L+2E
MA3404	Statistical Computing	5	SuSe	English	2L+1E
MA3409	Applied Regression	5	WiSe	English	2L+1E

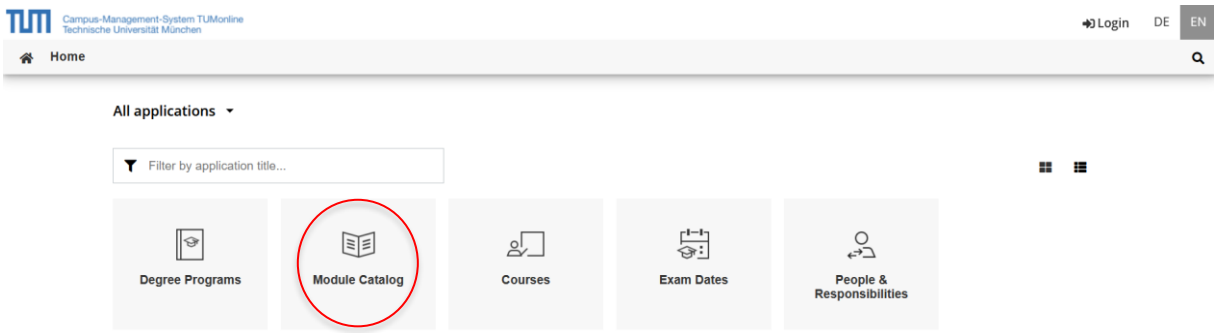
Numerics, Optimization and Biomathematics

Module Number	Name	ECTS (credit points)	WiSe / SuSe	Teaching Language	Academic hours per week*
MA0008	Numerical Analysis	9	WiSe	German	4L+2E
MA2012	Introduction to Optimization	9	SuSe	German	4L+4E
MA2902	Case Studies: Mathematical Modelling	9	WiSe	German	4L+2E

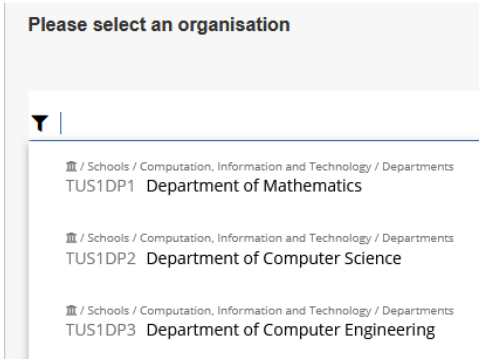
* 1 ECTS is equivalent to 30h workload per semester. L = Lecture, E = Exercise lesson

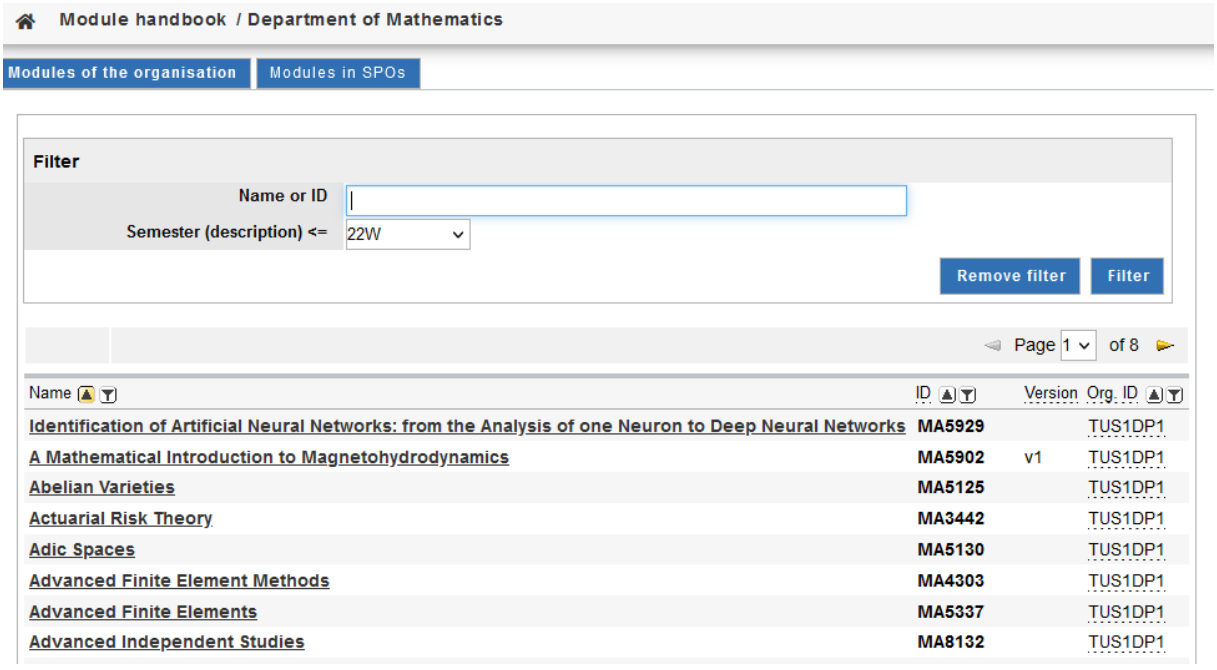
3. How to get more specific information about a course – the *Module Catalogue*

If you want to have specific information about a course, you click on *Module Catalogue* and select *TUM Department of Mathematics*.

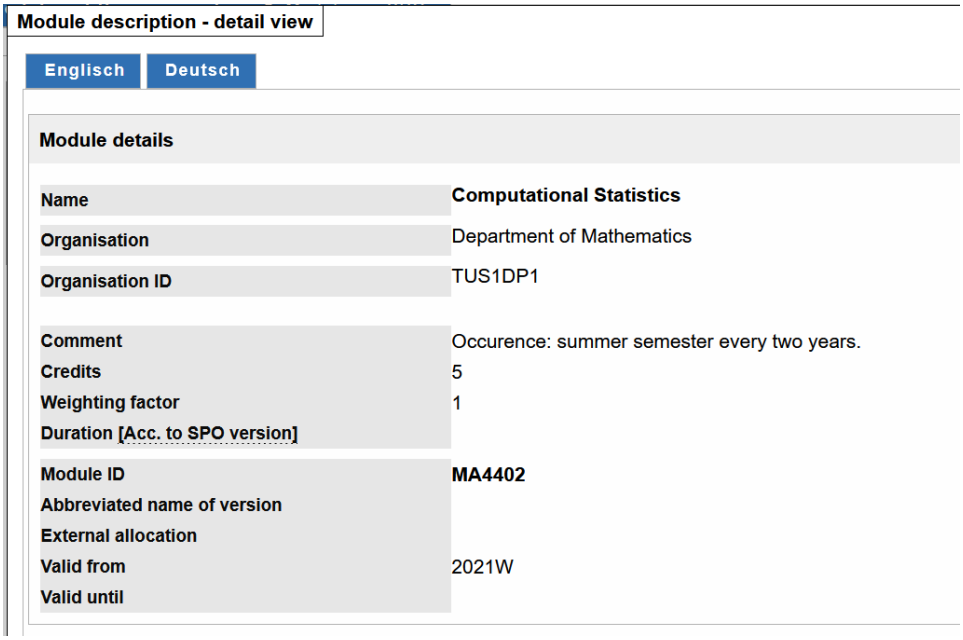


There you will find a list of all the modules that have ever been offered at the TUM Department of Mathematics (even expired ones). Choose *Department of Mathematics* as organization. You can search by course ID or name:





To get detailed information about a course, you simply click on its name. Here you see the details of MA4402 Computational Statistics as an example:



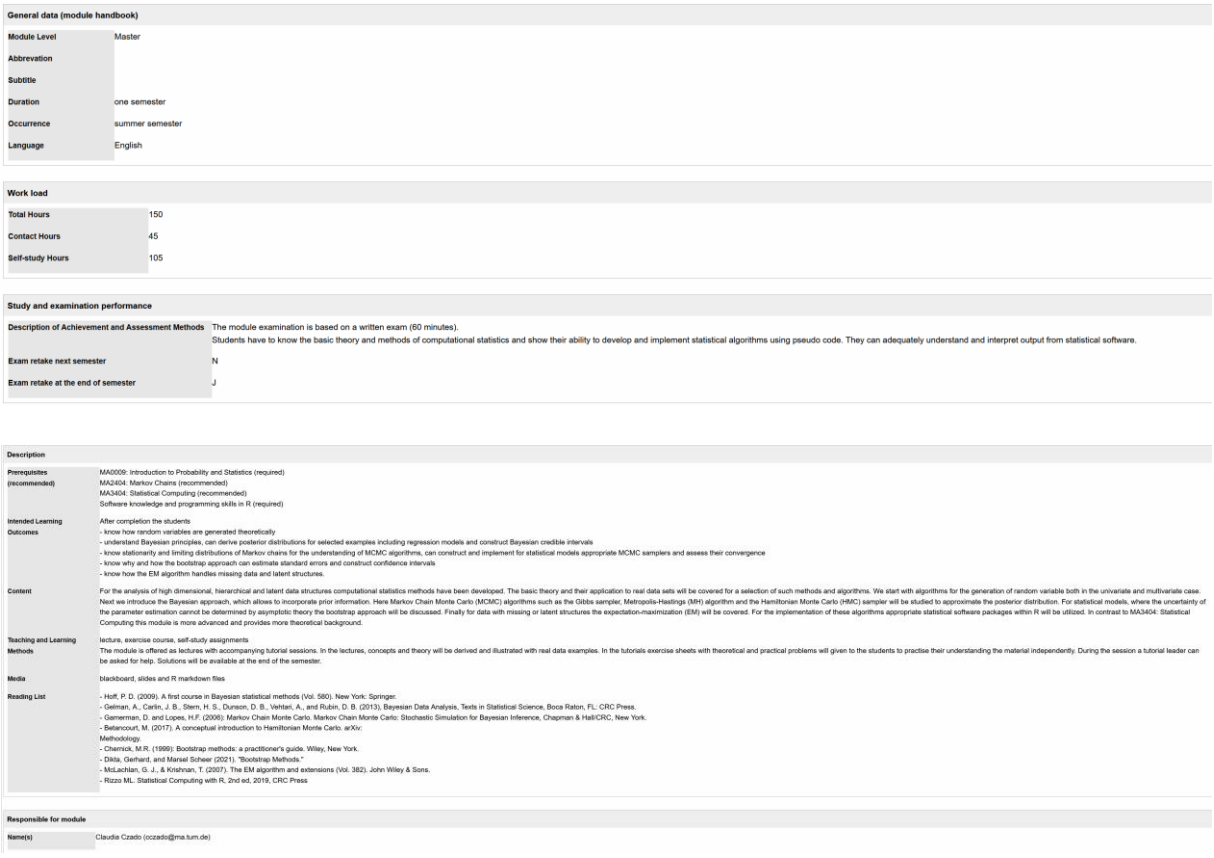
Module description - detail view

Englisch | Deutsch

Module details

Name	**Computational Statistics**
Organisation	Department of Mathematics
Organisation ID	TUS1DP1
Comment	Occurence: summer semester every two years.
Credits	5
Weighting factor	1
Duration [Acc. to SPO version]	
Module ID	**MA4402**
Abbreviated name of version	
External allocation	
Valid from	2021W
Valid until	

In the *Module Catalogue* you will find all relevant information like the ECTS, workload, level, occurrence, teaching language, content description, learning outcome and recommended literature. If a course has expired you will find this info under *Valid until.*



General data (module handbook)

Module Level	Master
Abbrevation	
Subtitle	
Duration	one semester
Occurrence	summer semester
Language	English

Work load

Total Hours	150
Contact Hours	45
Self-study Hours	105

Study and examination performance

Description of Achievement and Assessment Methods	The module examination is based on a written exam (60 minutes). Students have to know the basic theory and methods of computational statistics and show their ability to develop and implement statistical algorithms using pseudo code. They can adequately understand and interpret output from statistical software.
Exam retake next semester	N
Exam retake at the end of semester	J

Description

Prerequisites (recommended)	MA0009: Introduction to Probability and Statistics (required) MA2404: Markov Chains (recommended) MA3404: Statistical Computing (recommended) Software knowledge and programming skills in R (required)
Intended Learning Outcomes	After completion the students - know how random variables are generated theoretically - understand Bayesian principles, can derive posterior distributions for selected examples including regression models and construct Bayesian credible intervals - know stationarity and limiting distributions of Markov chains for the understanding of MCMC algorithms, can construct and implement for statistical models appropriate MCMC samplers and assess their convergence - know why and how the bootstrap approach can estimate standard errors and construct confidence intervals - know how the EM algorithm handles missing data and latent structures.
Content	For the analysis of high dimensional, hierarchical and latent data structures computational statistics methods have been developed. The basic theory and their application to real data sets will be covered for a selection of such methods and algorithms. We start with algorithms for the generation of random variable both in the univariate and multivariate case. Next we introduce the Bayesian approach, which allows to incorporate prior information. Here Markov Chain Monte Carlo (MCMC) algorithms such as the Gibbs sampler, Metropolis-Hastings (MH) algorithm and the Hamiltonian Monte Carlo (HMC) sampler will be studied to approximate the posterior distribution. For statistical models, where the uncertainty of the parameter estimation cannot be determined by asymptotic theory the bootstrap approach will be discussed. Finally for data with missing or latent structures the expectation-maximization (EM) will be covered. For the implementation of these algorithms appropriate statistical software packages within R will be utilized. In contrast to MA3404: Statistical Computing this module is more advanced and provides more theoretical background.
Teaching and Learning Methods	lecture, exercise course, self-study assignments The module is offered as lectures with accompanying tutorial sessions. In the lectures, concepts and theory will be derived and illustrated with real data examples. In the tutorials exercise sheets with theoretical and practical problems will given to the students to practise their understanding the material independently. During the session a tutorial leader can be asked for help. Solutions will be available at the end of the semester.
Media	blackboard, slides and R markdown files
Reading List	- Hoff, P. D. (2009). A first course in Bayesian statistical methods (Vol. 580). New York: Springer. - Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., and Rubin, D. B. (2013), Bayesian Data Analysis, Texts in Statistical Science, Boca Raton, FL: CRC Press. - Gamerman, D. and Lopes, H.F. (2006): Markov Chain Monte Carlo. Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman & Hall/CRC, New York. - Betancourt, M. (2017). A conceptual introduction to Hamiltonian Monte Carlo. arXiv: Methodology. - Chernick, M.R. (1999): Bootstrap methods: a practitioner's guide. Wiley, New York. - Dikta, Gerhard, and Marsel Scheer (2021). "Bootstrap Methods." - McLachlan, G. J., & Krishnan, T. (2007). The EM algorithm and extensions (Vol. 382). John Wiley & Sons. - Rizzo ML. Statistical Computing with R, 2nd ed, 2019, CRC Press

Responsible for module

Name(s)	Claudia Czado (cczado@ma.tum.de)

Please note that you should meet the prerequisites for the courses you choose, otherwise it will be challenging to pass the exam in the end. Recommended prerequisites are also shown in the Module description:

Prerequisites (recommended)	MA0009: Introduction to Probability and Statistics (required) MA2404: Markov Chains (recommended) MA3404: Statistical Computing (recommended) Software knowledge and programming skills in R (required)

Please be aware that only because the title and the information might be in English, this does NOT imply that the course is for sure offered in English. Binding is the language (of instruction) as written in the *General Data (module handbook)* section.

4. Categories of courses - Mathematics

Lectures and Exercises:

Most exchange students attend lectures during their stay. In Mathematics each lecture has corresponding exercises and one exam at the end of the semester. If students pass the exam they will receive a grade and the respective number of ECTS mentioned in the module catalogue. No limited capacity.

Seminars:

Students work on a scientific topic and present it to a group of fellow students. By giving a talk, discussing the topic and regular attendance students learn necessary presentation and discussion techniques. Limited capacity, separate registration process, prioritization of degree students. Exchange students can only apply for one of the remaining spots after the main selection round is finished.

Case Studies:

In our case studies students work in small groups on real projects in cooperation with external partners. By combining study and practice, students develop and implement suitable solutions with a high degree of personal responsibility and present their results in a final workshop with discussion to a broader audience. Limited capacity, only master's students.

5. Tips for making up your study plan (also Learning Agreement):

1. Search for courses in the *module catalogue* (not under *courses*) and click on the course's name you are interested in for the details.
2. Check whether the course has the level you want and find out about the occurrence, ECTS, language of instruction and content.
3. To be safe regarding the occurrence it is recommendable to stick to the regular modules mentioned above. Modifications can be made later!
4. In your own interest: please make sure you meet the prerequisites for each chosen course by taking a close look into the content descriptions of the prerequisite courses in TUMonline.
5. Be aware that sometimes you will have to change the subjects again when you come to TUM.
6. Please note that 60% of your courses have to be from the Mathematics Department, only 40% from other departments (language courses do not count).

If you have further questions please feel free to contact Ms. Julia Cyllok, our International Student Advisor: international@ma.tum.de