Wahlmodul Angewandte Mathematik
Seminarangebot SoSe 2024

Deutscher Titel	Englischer Titel	Dozierende	Niveau	Englisch	Beschreibung	Voraussetzungen	Literatur	Lehrstuhl	Dozierenden-E-Mails
Computational Algebra and Algebraic Statistics	Computational Algebra and Algebraic Statistics	Mathias Drton	Ba/Ma	✓	Algebraic statistics aims to use algebraic and geometric tools to address open problems in statistics. In this seminar students will learn some background about computational algebra and Gröbner bases. They will then learn how algebraic tools can be applied to study problems in statistics. Statistical topics of interest include conditional independence models, likelihood inference, log-linear models, graphical models, and parameter identifiability.		Cox D, Little J, and O'Shea D. 2007. Ideals, Varieties and Algorithms. Undergraduate Texts in Mathematics. Springer-Verlag. Sullivant S. 2018. Algebraic Statistics. Graduate Studies in Mathematics. American Mathematical Society. Drton M, Sturmfels B, Sullivant S. 2009. Lectures on Algebraic Statistics. Birkh\"auser. Sturmfels B. 1996. Gröbner bases and convex polytopes. University Lecture series, Volume 8.	M4	mathias.drton@tum.de
Evolution und Koaleszenz	Evolution and Coalescent	Volker Gerd Jürgen Hösel, Johannes Müller	Ba/Ma	✓	When did mankind leave Africa? How long did Neanderthals and Homo sapience live in Europe at the same time? How many rhinos live in Africa? We will not be able to conclusively clarify these questions in the seminar, but we will discuss the methods used to answer them: A sample of individuals is sequenced. How do we use these genetic data to answer questions like the ones above? The theory behind this is the coalescent. We ask ourselves how long ago the sample of two or more individuals had a common ancestor (or more fundamentally: has the group always had a common ancestor)? If we can estimate this time, we can also determine the statistics of the mutations acquired since then. This is the key to many exciting genetic analyses in population genetics. This seminar is a joint seminar with Prof. Aurelien Tellier from the School of Life Science: The plan is that pairs of maths and biology students discuss a topic, each from their own perspective. In that, not only interdisciplinary cooperation will be trained, but we also expect to reach a deeper level of understanding.		Richard Durrett Probability Models for DNA Sequence Evolution Springer, 2008 and original research articles.	M12	volker.hoesel@tum.de, johannes.mueller@mytum.de
Mengentheorie	Set Theory	Gregor Kemper	Bachelor	✗	In diesem Seminar werden wir die axiomatische Mengenlehre nach Zermelo-Fraenkel entwickeln. Wichtige Schritte sind der Nachweis der Äquivalenz von Auswahlaxiom, Zornschem Lemma und Wohlordnungssatz. Die Theorie der Mächtigkeiten liefert uns eine Hierarchie der Unendlichkeiten. Gegen Ende beschäftigen wir uns mit Kardinalzahlarithmetik, mit deren Hilfe man in vielen Fällen bestimmen kann, wo sich eine gegebene Menge in dieser Hierarchie befindet. Das Seminar ist gut geeignet für Studierende mit einer Neigung zur Abstraktion.	Analysis 1, Lineare Algebra 1	P. Halmos: "Naive Mengenlehre", Vandenhoeck & Ruprecht, Göttingen G. Kemper, F: Reimers: "Lineare Algebra: Mit einer Einführung in diskrete Mathematik und Mengenlehre", Springer Spektrum 2021	Algorithmische Algebra	kemper@tum.de
Digitale Darstellungen von Daten	Digital Representations of Data	Felix Krahmer	Master	✗	In order to efficiently store and process data, it is important to find efficient representations in terms of just a finite number of bits. In this seminar, we will discuss and mathematically analyze methods to find such representations in various scenarios. Examples of data types of interest include bandlimited signals, discrete vectors, and neural networks. Please note: The participants will be teamed up in groups of two-three and will give joint presentations, every student will be part of two such groups and will hence partially present two topics.	Analysis 1/2, Linear Algebra 1/2, Measure and Integration. Knowledge in probability and/or statistics will be helpful, but not required, in particular the class Probabilistic Methods and Algorithms in Data Analysis.	We will be working with recent research articles that have been published in mathematics, computer science, and electrical engineering journals such as S. Güntürk. One-bit Sigma-Delta quantization with exponential accuracy S. Gunturk, M. Lammers, A. Powell, R. Saab, and Ö. Yilmaz. Sobolev Duals for Random Frames and Sigma-Delta Quantization of Compressed Sensing Measurements E. Lybrand, R. Saab. A greedy algorithm for quantizing neural networks H. Li et al. Training quantized nets: a deeper understanding F. Krahmer, R. Ward. Lower bounds for the error decay incurred by coarse quantization schemes S. Güntürk, W. Li. Approximation of functions with one-bit neural networks	Professur für Optimierung und Datenanalyse	felix.krahmer@tum.de
Klassische Numerische Analysis	Classical Numerical Analysis	Caroline Lasser	Ba/Ma	✗	The seminar is a reading course of selected chapters of the book "Classical Numerical Analysis" by A. Salgado and S. Wise (Cambridge University Press, 2023).		A. Salgado and S. Wise, Classical Numerical Analysis (Cambridge University Press, 2023).	npdg	classer@tum.de

Geometric Folding Algorithms: Linkages, Origami, Polyhedra	Geometric Folding Algorithms: Linkages, Origami, Polyhedra	Stefan Weltge	Master	✓	Did you know that it is possible to design a series of jointed bars moving in a flat plane that can sign your name or trace any other algebraic curve? Or, did you know that one can fold any straight-line drawing on paper so that the complete drawing can be cut out with one straight scissors cut? This seminar is concerned with the mathematics of geometric folding and unfolding with an emphasis on algorithmic aspects. We will study how particular objects such as linkages, pieces of paper (origami), polyhedra, or proteins can be reconfigured or folded according to a few constraints, which depend on the object being folded and the problem of interest. Such problems have been implicit since Albrecht Dürer in the early 1500s, but have only recently been studied in the mathematical literature. The types of results that we will cover can be characterized in the following way. 1. For certain models of folding there exist universailty results, which show that everything is possible. Typically, these results even come with efficient algorithms for finding the folding. 2. If not everything is possible, one can hope for efficient (polynomial) algorithms to decide whether an object is foldable, and if so, for finding an efficient folding. 3. However, sometimes even this seems impossible: hardness results prove that even deciding whether an object is foldable in a particular way is computationally intractable. During the seminar, we will also cover applications to architecture, robotics, manufacturing, and biology. IMPORTANT: We assume basic knowledge of complexity theory and familiarity with notions such as P, NP, NP-hardness.		Erik D. Demaine, Joseph O'Rourke: Geometric Folding Algorithms	Discrete Mathematics	weltge@tum.de
Iterative Löser und Vorkonditionierer für lineare Gleichungssysteme	Iterative solvers and preconditioners for systems of linear equations	Elisabeth Ullmann	Bachelor	✗	In this seminar we read the book "Iterative methods and preconditioners for linear systems of equations" by Ciaramella and Gander (SIAM). An electronic copy of the book is available in the TUM OPAC. - Quote from the webpage of the book (https://epubs.siam.org/doi/book/10.1137/1.9781611976908, accessed on 17 Dec 2023): "Iterative methods use successive approximations to obtain more accurate solutions. This book gives an introduction to iterative methods and preconditioning for solving discretized elliptic partial differential equations and optimal control problems governed by the Laplace equation, for which the use of matrix-free procedures is crucial. All methods are explained and analyzed starting from the historical ideas of the inventors, which are often quoted from their seminal works."	Numerik (MA0008)	https://doi.org/10.1137/1.9781611976908	Scientific Computing and Uncertainty Quantification	elisabeth.ullmann@tum.de
Gitter in der Kryptographie	Lattices in Cryptography	Lorenz Panny	Master	✓	In this seminar, we will dive into the applications of lattices in cryptography, with a primary focus on post-quantum cryptography. The selection of topics is fairly flexible and can range from theoretical complexity results to fast implementation techniques. A good understanding of algebra and algorithms is required. Prior knowledge of cryptography is not strictly required, but will be very helpful. Familiarity with computer algebra, complexity theory, or algebraic number theory will be needed for some topics.		For an overview: D. Micciancio and O. Regev, "Lattice-based Cryptography," Post-Quantum Cryptography. Springer Berlin Heidelberg, pp. 147-191. doi: 10.1007/978-3-540-88702-7_5. Suitable sources for each seminar topic will be provided.	Professur für Kryptographie	lorenz.panny@tum.de
Algorithmic Game Theory	Algorithmic Game Theory	Alexander Grosz	Bachelor	✗	- How bad is it that drivers can choose their own route in a street network? (Selfish Routing) - What's the best bidding strategy at an online auction? ((Combinatorial) Auctions) - How difficult is it to find an equilibrium in a game? (Computing in Games) - How are online ads being sold? (Sponsored Search Auctions) - Can you strategize in democratic voting? Do better voting rules exist? (Social Choice, Voting Rules) - How do you cut a cake? (Fair Division) - Whose kidney is going to be transplanted? (Matching under Preferences) All of these question can be posed in the fields of algorithmic game theory and mechanism design, where strategic agents interact directly or indirectly with each other by some game or mechanism. In this seminar, students are going to discuss a selected topic each and thereby encounter a variety of questions, methods and applications.	Mathematische Grundvorlesungen	- Nisan et al. - Algorithmic Game Theory - Roughgarden - Twenty Lectures on Algorithmic Game Theory - Brandt et al. - Handbook of Computational Social Choice	Operations Research	alexander.grosz@tum.de