

| Deutscher Name  | Englischer Name                                       | Dozierende                      | Bachelor-Plätze | Master-Plätze | Englisch | Beschreibung  | Voraussetzungen  | Literatur   | Geeignet für Lehramtsstudiierende |
|---|---|---------------------------------|-----------------|---------------|----------|---|--|---|-----------------------------------|
| Gems of Discrete Optimization                             | Gems of Discrete Optimization                         | Andreas Schulz, Alexander Grosz | 8               | 0             | ✓        | Are you looking to deepen your knowledge of discrete structures and optimization? All while enjoying some beautiful mathematical ideas and algorithmic techniques?<br>Gems of Discrete Optimization uses a handpicked collection of recent papers focussing on problems and results in combinatorial optimization and algorithmic graph theory.<br><br>The seminar is aimed at students who enjoyed Discrete Structures and Introduction to Optimization. The seminar may be held online. The kick-off meeting will take place in the first week of the next term.  | Lineare Algebra 2 und Diskrete Strukturen  | Gems of Combinatorial Optimization and Graph Algorithms (Eds. Schulz, Skutella, Stiller, Wagner)  | ✓                                 |
| Fortgeschrittene Graphenalgorithmen                       | Advanced Graph Algorithms                             | Andreas Schulz, Alexander Grosz | 4               | 4             | ✓        | Dijkstra, Kruskal, and Ford-Fulkerson are examples of well-established algorithms on graphs and networks - but there's much more to discover!<br>In this seminar, we will discuss and analyze a broad range of other problems and algorithms on graphs, such as<br>Finding min cuts in undirected graphs,<br>The push-relabel algorithm for computing maximum flows,<br>Approximating a Steiner tree,<br>Constructing a tree decomposition of a graph,<br>Coloring a graph,<br>Computing minimum mean cycles.   | Basic knowledge of graphs and fundamental graph algorithms   | TBA   | ✓                                 |
| Discrete optimization in practice                         | Discrete optimization in practice                     | Andreas Wiese                   | 0               | 10            | ✓        | In this seminar, we will study how discrete optimization can be used to solve problems in practice using techniques like mixed-integer programs or combinatorial algorithms. We will cover various application settings like scheduling, logistics, or network design. After this seminar, you will know much better how discrete optimization techniques can be applied in real-world scenarios, and it will be easier for you to apply them yourself in the organization you (will) work for.   | Knowledge of linear programs, integer programs, and combinatorial optimization algorithms                                    |   | ✓                                 |
| Irrfahrten in deterministischen und zufälligen Umgebungen | Random walks in deterministic and random environments | Silke Rolles                    | 8               | 4             | X        | Random walks have been an active research area for many decades. We will start the seminar with an elementary introduction to the classical theory of random walks on graphs and lattices. A connection with electrical networks provides a beautiful theory which allows e.g. to compare different random walks and to calculate escape probabilities. In particular, we will see a prove of Polya's theorem concerning recurrence and transience on integer lattices.<br>In the second part of the seminar, we move from deterministic to random environments. The talks will provide a gentle introduction to the theory of random walks in random environments. | Einführung in die Wahrscheinlichkeitstheorie und Statistik (MA0009) oder Einführung in die Wahrscheinlichkeitstheorie MA1401 | Main references:<br>P. Doyle and J. Snell: Random walks and electric networks, Mathematical Association of America, 1984, <a href="https://arxiv.org/abs/math/0001057">https://arxiv.org/abs/math/0001057</a><br>A. Drewitz and A. Ramirez: Selected Topics in Random Walk in Random Environment, PASI Proceedings: Topics in percolative and disordered systems, <a href="https://arxiv.org/abs/1309.2589">https://arxiv.org/abs/1309.2589</a> | ✓                                 |
| Codierungstheorie   | Coding theory   | Gregor Kemper                   | 10              | 2             | X        | Die Codierungstheorie beschäftigt sich mit der sicheren Datenübertragung und Datenspeicherung. Dabei geht es nicht um die Sicherung der Vertraulichkeit gegenüber Angriffen Dritter, was das Thema der Kryptographie ist, sondern um eine möglichst hohe Sicherheit, die Daten auch bei Fehlern in der Übertragung wieder herstellen zu können. Die Untersuchung von guten Codes ergibt eine interessante mathematische Theorie, die auf Aspekten der linearen Algebra und der Algebra aufbaut.   | Lineare Algebra und Diskrete Strukturen 1&2  | J.H. van Lint: Introduction to Coding Theory, Springer-Verlag 1992<br>O. Pretzel: Error-Correcting Codes and Finite Fields, Clarendon Press 1992  | ✓                                 |
| Neue Entwicklungen in der Nichtlinearen Optimierung       | Recent Developments in Nonlinear Optimization         | Michael Ulbrich                 | 4               | 4             | ✓        | The seminar is centered around recent advances in nonlinear optimization and related fields. It also serves as a preparation for a Bachelor's or Master's thesis in this area. The talks cover innovative developments in the following fields: Optimization theory; efficient numerical solvers and their convergence theory; optimization of complex systems; stochastic and robust optimization; optimal control; game theory; applications in data science and machine learning, technology, engineering, natural sciences, etc.  |  | The talks are typically based on recent journal publications.<br><br>Requirements for participation:<br><br>For Bachelor students:<br>Einführung in die Optimierung (MA2012) recommended, but not mandatory, is also Nonlinear Optimization (MA3503)<br><br>For Master students:<br>Einführung in die Optimierung (MA2012) or Nichtlineare Optimierung: Grundlagen (MA2503) Nonlinear Optimization (MA3503)                                     | ✓                                 |
| Hochdimensionale Wahrscheinlichkeitstheorie               | High Dimensional Probability                          | Felix Krahmer, Hanna Veselovska | 2               | 7             | ✓        | This seminar will cover random objects in high-dimensional space, in particular, random vectors, random matrices, and random projections. We will discuss a selection of theoretical skills for the analysis of these objects, such as concentration inequalities, covering and packing arguments, decoupling and symmetrization tricks, chaining, and comparison techniques for stochastic processes.  | Introduction to Probability and Statistics Probability Theory and/or Probabilistic Methods and Algorithms for Data Analysis  | R. Vershynin, High Dimensional Probability - An Introduction with Applications in Data Science, Cambridge University Press  | ✓                                 |
| Probabilistische Numerik                                  | Probabilistic Numerics                                | Caroline Lasser                 | 6               | 6             | X        | The seminar is a reading course of selected chapters of the book "Probabilistic Numerics" by P. Hennig, M. Osborne, H. Kersting (Cambridge University Press, 2022).   | Solide Kenntnisse in Analysis, linearer Algebra und Numerik.   | Probabilistic Numerics, P. Hennig, M. Osborne, H. Kersting (Cambridge University Press, 2022)   | ✓                                 |

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| Mathematische Modellierung der Welt der Bakterien | Mathematical modelling of the bacterial world | Christina Kuttler | 6 | 6 | ✓ | <p>Biomathematics in general deals with the development and application of mathematical methods and models to answer interesting questions from life sciences.</p> <p>We focus here on an often invisible world:<br/>Bacteria are organisms which are – against first impression of being very simple organisms – often living in and forming complex structures, interacting, sending and receiving signals and more. In this seminar we want to consider bacterial life from a mathematical perspective, get to know typical modelling approaches and mathematical tools to deal with them.</p> <p>Each seminar talk will be based on current original publications.<br/>Some basic knowledge about Biomathematics (e.g. from the lecture “Mathematical models in Biology” or similar) is expected and helpful. Attendance of this lecture in parallel to the seminar can be an option.</p> <p>Lehramtsstudierende sind ebenfalls herzlich willkommen, hier sind Vorkenntnisse zu gewöhnlichen Differentialgleichungen sehr hilfreich.</p> <p>Welcome to explore the fascinating bacterial world by Mathematics!</p> <p>If there are questions already during the application process, please contact me by email:<br/>kuttler@ma.tum.de</p>  | Mathematical models in Biology<br>Mathematische Grundvorlesungen | Original papers, will be chosen according to the previous knowledge of the participants.   | ✓ |
| Evolution von Staaten and Institutionen (m)       | Evolution of states and institutions (m)      | Johannes Müller   | 2 | 3 | X | <p>(This is a joint seminar with Matthias Gsänger, Faculty of political sciences of the Julius Maximilians University Würzburg, and will take place in German language)</p> <p>Das Seminar wird primär internetbasiert stattfinden, wir planen aber ein gemeinsames Kickoff Wochenende in einem Tagungshaus (Unterkunft wird von TUM/JMU gezahlt, Termin steht noch nicht fest, vermutl. Anfang Oktober).</p> <p>Politische Institutionen - Staaten, aber auch Institutionen wie Parlamente oder Rechtssysteme, und allgemein, Regeln die das Zusammenleben organisieren kommen nicht aus dem Nichts sondern haben sich langsam entwickelt.</p> <p>In diesem Seminar, das im Spannungsfeld zwischen Biomathematik und Politologie stattfindet, wollen wir zusammen mit Studierenden der Politologie (JMU) explorieren, inwieweit sich Konzepte, insbesondere aus dem Bereich der mathematischen Evolutionstheorie, auf Aspekte der Entwicklung politischer System übertragen lassen. Ein solcher Ansatz kann unser Verständnis politischer Systeme vertiefen.</p> <p>Das Seminar ist eine Fortsetzung eines experimentellen, ähnlich konzipierten Seminars des letzten Wintersemesters, in dem erste, sehr interessante Ergebnisse in dieser Richtung entwickelt wurden auf die wir jetzt aufbauen.</p> <p>Da wir ein sozialwissenschaftliches Thema bearbeiten, wäre eine Gruppe, in der Frauen und Männer gleich stark vertreten sind, wünschenswert. In diesem Zweig des Seminars melden sich bitte nur Studenten (m) an, es gibt einen parallelen Zweig, in dem sich Studentinnen (w) anmelden können. Diverse Personen melden sich</p> |  | <p>Ein interessantes Buch aus der Politologie<br/>Spruit, The Sovereign State and Its Competitors, Princeton Univ. Press, 1996<br/>Für die Evolutionstheorie:<br/>Okasha, Evolution and the Levels of Selection, Oxford Univ. Press 2006<br/>Einige Modelle zwischen Sozialwissenschaften und mathematischer Biologie finden Sie hier:<br/>Epstein, Nonlinear Dynamics, Mathematical Biology, and Social Science, Westview Press, 1997</p> | ✓ |

