Universität Konstanz

Master's Programme in Social and Economic Data Science

Modul handbook
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University of Konstanz
Faculty of Law, Economics, and Politics
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Kontakt

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Qualification objectives

I. Competences

Subject-specific competences:
Broadening of knowledge: To make sure that all students meet the same academic standards, they will attend fundamental courses from outside their original academic field during their first and second semester. At the end of the second semester, all students have a basic knowledge in the following focus areas: computer sciences, mathematics, statistics and social-scientific methods. The students will be able to collect, manage and analyse data of different kinds and from various sources, to interpret and communicate the results in order to gain new insights and to support decision making.
Deepening of knowledge: In the subsequent semesters, the students select advanced modules from the Master's programmes at the participating departments. A data science project or an internship will serve the development of practical skills. The Master's thesis is then to be written in the student's field of choice.
Generic competences: The students are in a position to quickly and independently delve into new subjects. They can apply the methods acquired during the Master's programme. The students are able to present their findings in English. They can enter into a critical dialogue with others about the underlying premises and the methods used to derive the findings.

II. Learning Outcomes

- In written exams, students prove that they have an in-depth understanding of the core concepts in social and economic data science and that they can apply these concepts to solve simple problems in a short time.
- In advanced classes, students write short essays that satisfy scientific standards and reveal a detailed knowledge in special areas.
- In tutorials, students show that their knowledge and skills enable them to also solve more complex tasks. They work successfully in teams and present their results to other students, who discuss these results critically.
- In seminars, students show that they can grasp the essence of scientific papers and can organize the insights distilled from the literature in a well-structured manner. They communicate these insights to their fellow students and respond adequately to critical questions from the audience. Moreover, they formulate critical questions about other students' presentations. The students write seminar papers on topics of their choice. For this purpose, they draw on the modern scientific literature and relate the findings in a meaningful way. They develop own ideas for small research projects and design approaches to solving these problems.
- In the Master's thesis, students demonstrate their ability to formulate more extensive research questions and to address them with the help of modern tools. They organize the time period of several months for the preparation of the thesis independently and effectively. They are successful in developing a clear and logical structure for an extensive research project. They critically assess the applied methods and premises and derive convincing conclusions.

Introduction

This handbook provides outlines of the modules offered for the Master's Programme in Social and Economic Data Science. Aside from the Master's thesis, the modules are:

- courses comprising lectures and tutorials
- courses comprising lectures
- seminars

All students take the compulsory module "Introduction to Computational Methods for the Social Sciences".
The remaining courses are grouped under the following modules

1. Foundations of Data Science
2. Advanced Methods: Computer Science
3. Advanced Methods: Statistics
4. Programming and Scripting
5. Social Science Applications
6. Master Thesis

Each course outline gives the following information:

Applicability	Specifies the module to which the course belongs.
Credits	Each module has a credit value based on the student's workload required to successfully complete the module, in accordance with the European Credit Transfer and Accumulation System (ECTS). To complete the Master's programme, 120 credits in total are required and 30 credits per semester should be accumulated. Students, aside from the Master's thesis and colloquium (27 credits), need to obtain 93 credits in taught modules (courses and seminars).
Learning Outcomes	Describes what students should be able to do on completing the module.
Content of Teaching	Describes the topics covered in the module.
Teaching Methods / Hours per week	The type of module (a course comprising lectures, with or without tutorials, or a seminar) and its hours of tuition per week.
Workload	The workload indicates the time students typically need to spend to successfully complete the module.
Recommended Background	Indicates whether specific prior knowledge would be beneficial for completing the module.
Language	The modules of the Master's programme are taught in English or German.
Frequency Offered	The semester in which the module is taught (winter semester, summer semester or both winter and summer semester).
Recommended Semester	Specifies in which semester it is recommended to take the module.
Compulsory / Optional	Informs whether the module must be taken to complete the Master's programme.
Department	Department which offers the module

Some of the module descriptions below are in german because the respective course is offered in german.

Introduction to Computation for the Social Sciences

Applicability *Introduction to Computation for the Social Sciences*					
Credits	9 Cr	**Duration**	1. Sem	**Module Contribution to the Final Grade**	8,33%
Learning Outcomes		Students know and understand basic concepts of information coding, storing and processing and their application in social science research.			
Content of Teaching		This lecture serves as an introductory course to computer science and programming for a social science audience. The main emphasis of the course is on providing students with a good conceptual understanding of fundamental principles in computer sciences and of basic programming concepts. Topics covered range from basic principles of information coding, computer systems and information storage, to data types, data structures, algorithms, different programming paradigms and database systems. Concepts are taught “in context” throughout the lecture, i.e., students will learn concepts and directly apply them in programming exercises structured along relevant social science applications. The lecture will rely on Python as teaching language.			
Teaching Methods Hours per Week		Lecture (2 hours) with Exercise (2 hours)			
Workload		270 hours			
Type of Assessment		Final exam of 90 min. Students are required to successfully complete at least 60% of the exercises to qualify for the final exam. The final grade for the course corresponds with the exam grade.			
Recommended Background					
Language		English			
Frequency Offered		Winter semester			
Recommended Semester		1			
Compulsory / Optional		Compulsory			
Department		Department of Economics			

Subject Area 1: Foundations of Data Science

Computer Sciences

Data Mining: Basic Concepts

Applicability *Foundations of Data Science / Computer Science*					
Credits	6 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Students obtain the ability to assess requirements and parameters for the application of fundamental analysis algorithms. Beyond that, students will practically apply and assess the results in an autonomous way.				
Content of Teaching	The students are taught elementary theoretical knowledge and get first practical experience in the data analysis domain.				
Workload	180 hours				
Type of Assessment	Written exam or oral exam (depends on the number of students) and successful attendance of the tutorial (at least 50% of reachable points). The final grading is only reflecting the performance in the exam.				
Recommended Background					
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in the module Foundation of Data Sciences is individually scheduled for each student by the admissions committee.				
Department	Department of Computer and Information Sciences				

Data Visualization: Basic Concepts

Applicability *Foundations of Data Science / Computer Science*					
Credits	6 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Students understand the principles of Data Visualization.				
Content of Teaching	“Data Visualization: Basic Concepts“ gives an introduction to the field of Data Visualization. In particular, it covers foundations, relevant aspects of human perception, visualization design principles, and some basic visualization techniques for different data types (e.g., multi-dimensional, hierarchical, and spatial).				
Workload	180 hours				
Type of Assessment	Depending on the number of participants, oral exam (of 30 minutes duration), or written exam (of 120 minutes duration). Eligibility to take part in the exam requires students to achieve at least 50% of the points from the exercise/tutorial program. The final grade corresponds to the grade of the exam.				
Recommended Background	The lecture “Database Systems”. Basic programming skills and basic knowledge of databases and query languages.				
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee.				
Department	Department of Computer and Information Sciences				

Konzepte der Informatik + Programmierkurs I

Applicability *Foundations of Data Science / Computer Science*					
Credits	6 + 6 Cr	**Dauer**	1. Sem	**Anteil des Moduls an der Gesamtnote**	*
Module Grade	Klausur von Konzepte der Informatik				
Module units	• Konzepte der Informatik • Programmierkurs I				
Learning Outcomes	Absolventen kennen und verstehen die Grundlagen der Informationscodierung, -speicherung und –verarbeitung. Die Absolventinnen und Absolventen haben ein grundlegendes Verständnis der imperativen und objektorientierten Programmierung mit Java. Grundlegende Modelle können selbstständig implementiert werden.				
Module unit: Konzepte der Informatik					
Content of Teaching	• Informationscodierung und - speicherung - Codierung von Zahlen und Zeichen, Speicherbereiche, elementare Datentypen, Streuspeicherung • Übersicht über die verschiedenen Programmierparadigmen, ausführlich den Kern imperativer Sprachen und Objektorientierung • Algorithmen und Datenstrukturen - häufig verwendete Datenstrukturen wie Listen, Arrays, Stapel und Warteschlangen, Bäume und allg. Graphen; Eigenschaften von Algorihmen, insbesondere Algorithmenkomplexität und Korrektheit, sowie die algorithmische Konzepte Iteration und Rekursion, Teile und Herrsche, am Beispiel verschiedener Sortierverfahren • Theoretische Grundlagen - Einführung in die Automatentheorie sowie formale Sprachen und Grammatiken; Fragen der Berechenbarkeit von Problemen, Komplexität und Korrektheit von Algorithmen • Parallelisierung - auf Hardware- und Programmebene, Daten- und Aufgabenparallelisierung, Organisationsformen paralleler Programme, Grenzen der Parallelisierung				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS)				
Workload	180 Stunden				
Credits for this unit	6 Cr				
Type of Assessment	• Studienleistung: 60% der Punkte aus den Übungen, mindestens 40% pro Aufgabenblatt • Prüfungsleistung: Klausur von 90 Minuten Dauer, Teilnahmevorraussetzung ist das Absolvieren der Studienleistung • Die Note entspricht der Klausurnote				
Recommended Background	Konzepte der Informatik kann nur zusammen mit dem Programmierkurs I belegt werden.				

Language	German
Frequency Offered	Jedes Semester
Recommended Semester	1
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee.
Department	Department of Computer and Information Sciences
Module unit: Programmierkurs I	
Content of Teaching	• Objektorientierte Programmierung - die in der Vorlesung "Konzepte der Informatik" vorgestellten Konzepte objektorientierter Programmiersprachen wie Klassen, Vererbung, Polymorphismus, Ausnahmebehandlung oder generische Programmierung werden praktisch mit Java an Hand verschiedenster Beispiele geübt • Imperative Programmierung - Befehlsorientierte Programmierung mit Methoden, Schleifen und Auswahlbefehle. • Angewandte Programmierung - Programmqualität, Dokumentation und Testen von Programmen
Teaching Methods Hours per Week	Vorlesung (2 SWS) mit Übung (2 SWS)
Workload	180 Stunden
Credits for this unit	6 Cr
Type of Assessment	• nur unbenotete Studienleistung möglich • >60% der Punkte aus den Übungen • >70% des Projektes bearbeitet
Recommended Background	Der Programmierkurs I kann nur zusammen mit Konzepte der Informatik belegt werden.
Language	German
Frequency Offered	Jedes Semester
Recommended Semester	1
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee.
Department	Department of Computer and Information Sciences

Mathematics

Diskrete Mathematik und Logik

Applicability *Foundations of Data Science / Mathematics*					
Credits	9 Cr	**Duration**	1. Sem	**Module Contribution to the Final Grade**	*
Learning Outcomes	Einführung in die diskreten Methoden der Mathematik, wie sie für die Informatik wichtig sind. Ziel des Moduls ist ein konzeptionelles und operationales Verständnis von Begriffen, Resultaten und Techniken im Umgang mit logischen, kombinatorischen, graphentheoretischen und algebraischen Fragestellungen.				
Content of Teaching	• Mathematische Konstruktionen (Zuweisung, Iteration, Rekursion, strukturelle Induktion) • Elementare Logik (Aussagen, Quantoren, Beweise) • Mengen (Begriff, Mengenoperationen, Familien und Partitionen) • Relationen (Kreuzprodukt, Funktionen, Ordnungs- und Äquivalenzrelationen, Hüllen) • Kombinatorik (Grundprinzipien des Abzählens, Urnenmodelle, Anzahlkoeffizienten, Schubfachschluss) • Graphentheorie (gerichtete und ungerichtete Graphen, Bäume und gerichtete kreisfreie Graphen, planare Graphen, Färbungen von Graphen, Paarungen in Graphen) • Algebraische Strukturen (Grundbegriffe, Algebrentypen, Gruppen, endliche Körper) • Logische Systeme (Prädikatenlogik erster und zweiter Stufe, Modallogik)				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS)				
Workload	270 Stunden				
Type of Assessment	Mindestens 50% der Gesamtpunktzahl aus den wöchentlichen Übungsblättern für die Klausurzulassung. Prüfungsleistung: erfolgreiche Klausurteilnahme.				
Recommended Background					
Language	German				
Frequency Offered	Winter Semester				
Recommended Semester	1				

Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee
Department	Department of Computer and Information Science

Lineare Algebra I

Applicability *Foundations of Data Science / Mathematics*					
Credits	9 Cr	**Duration**	1. Sem	**Module Contribution to the Final Grade**	*
Learning Outcomes	Ein konzeptionelles und operationales Verständnis von Begriffen, Resultaten und Techniken im Umgang mit analytischen, linear-algebraischen und vektoranalytischen Fragestellungen.				
Content of Teaching	Algebraisches Grundwissen				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS)				
Workload	270 Stunden				
Type of Assessment	Klausur und Übungsteilnahme				
Recommended Background					
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Mathematics and Statistics				

Datenmathematik

Applicability *Foundations of Data Science / Mathematics*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Ein konzeptionelles und operationales Verständnis von Begriffen, Resultaten und Techniken im Umgang mit wahrscheinlichkeitstheoretischen, statistischen und numerischen Fragestellungen.				
Content of Teaching	Inhalt des Moduls ist die Einführung in die stochastischen Methoden der Mathematik, wie sie für die Informatik wichtig sind. Folgende Inhalte werden durch das Modul abgedeckt: • Mathematische Datenmodelle • Regressionsanalyse • Wahrscheinlichkeitsrechnung (diskret, kontinuierlich) - Induktive Statistik • Zufällige Prozesse • Iterationsverfahren • Stichprobenverfahren				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS)				
Workload	270 Stunden				
Type of Assessment	Studienleistung: mindestens 50% der Gesamtpunktzahl aus den wöchentlichen Übungsblättern für die Klausurzulassung. Prüfungsleistung: erfolgreiche Klausurteilnahme.				
Recommended Background	Kenntnisse entsprechend der Basismodule Mathematik 1 (Diskrete Mathematik und Logik) und Mathematik 2 (Analysis und Lineare Algebra)				
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Computer and Information Science				

Mathematik für Wirtschaftswissenschaftler I

Applicability *Foundations of Data Science / Mathematics*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Einführung in die Differential- und Integralrechnung einer Variablen, die Differentialrechnung mehrerer Veränderlicher sowie in die Optimierung.				
Content of Teaching					
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS)				
Workload	270 Stunden				
Type of Assessment	Klausur				
Recommended Background					
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Mathematics and Statistics				

Social Scientific Methods

Econometrics I

<table>
<tr><td colspan="6">Applicability
Foundations of Data Science / Social-scientific Methods</td></tr>
<tr><td>Credits</td><td>8 Cr</td><td>Duration</td><td>1. Sem.</td><td>Module Contribution to the Final Grade</td><td>*</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="4">On the completion of this course students will be acquainted with the fundamentals of regression analysis. They will understand to confront hypotheses from economic model theory with real world economic data. Students will learn to apply econometric software to pursue their own empirical research and will be able to interpret econometric findings critically.</td></tr>
<tr><td colspan="2">Content of Teaching</td><td colspan="4">• Multiple Linear Regression Model: LS-Estimation, Tests, Forecasting, Restricted LS-Estimation
• Problems of Model Specification: Autocorrelation, Heteroscedasticity, Functional Form
• Introduction to Dynamic Models
• Quantal Response Models
• Instrumental Variables Estimation
• Computer Tutorials with R</td></tr>
<tr><td colspan="2">Teaching Methods Hours per Week</td><td colspan="4">Lecture (3 hours) and tutorial (2 hours)</td></tr>
<tr><td colspan="2">Workload</td><td colspan="4">240 hours</td></tr>
<tr><td colspan="2">Type of Assessment</td><td colspan="4">Final exam (80%), mid-term exam (20%)</td></tr>
<tr><td colspan="2">Recommended Background</td><td colspan="4">Introductory linear algebra, calculus, probability and statistics</td></tr>
<tr><td colspan="2">Language</td><td colspan="4">English</td></tr>
<tr><td colspan="2">Frequency Offered</td><td colspan="4">Summer semester</td></tr>
<tr><td colspan="2">Recommended Semester</td><td colspan="4">2</td></tr>
<tr><td colspan="2">Compulsory / Optional</td><td colspan="4">The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee</td></tr>
<tr><td colspan="2">Department</td><td colspan="4">Department of Economics</td></tr>
</table>

Introduction to Survey Methodology

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	The aim of this course is to sensitize students for the problems of survey data and to equip them with the knowledge and skills necessary to critically conceptualize, evaluate and analyze sample-based surveys				
Content of Teaching	This lecture provides an overview over the theoretical and methodological principles of survey research. Most generally, the purpose of surveys is to describe populations based on data that is collected for a sample out of this population. The distinct steps in conducting surveys from sampling to questionnaire design are discussed from the viewpoint of potential errors that may occur when inferring population characteristics from surveys. The lecture is supplemented with a tutorial in which the methods, models and strategies discussed is implemented with existing and simulated data using R, a free software environment for statistical computing and graphics.				
Teaching Methods Hours per Week	Lecture (2 hours) and tutorial (2 hours)				
Workload	270 hours				
Type of Assessment	Final exam, active participation				
Recommended Background	Successful completion of the lectures ‚Methoden der Empirischen Politik- und Verwaltungsforschung' and ‚Statistik I' (or equivalents) is required.				
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Politics and Public Administration				

Empirical Research Methods

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	• Students are able to interpret and use the formal language, which is relevant for empirical social research. • Students are able to develop an appropriate research design to test a certain theoretical model by using empirical data. • Students are able to collect and analyze data according to the selected research design. • Students are able to identify possible sources of inferential errors and take measures. • Students are able to communicate their findings in an effective and efficient way.				
Content of Teaching	Empirical social science techniques are crucial not only for testing theories but also for further kinds of projects, which require systematic data collection and analysis. By using such techniques, we aim to make sound inferences, which enables us to know more from what we can observe. For sound inferences, one needs sound knowledge in formal language, philosophy of science, research designs, as well as details in data collection and processing techniques. This lecture introduces to the individual topics above and their implementation in concrete research situations. At the end of the lecture, students should be able to understand how to make inferences in empirical social research as well as to evaluate whether existing empirical projects make sound inferences.				
Teaching Methods Hours per Week	Lecture (4 SWS)				
Workload	270 hours				
Type of Assessment	Final exam				
Recommended Background					
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Politics and Public Administration				

Research Design I: Research Design and Causal Inference

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade** (The exact contribution depends on the weighting according to credits.)	*
Learning Outcomes		The course's primary aim is to provide students with the epistemological and methodological tools to critically evaluate existing empirical studies, to identify their inferential weaknesses, and to develop research designs on their own that, to the greatest possible extent, respond to these problems.			
Content of Teaching		This course offers an advanced treatment of design issues in political research that aims (as it usually does) at causal inference, i.e., at answering cause-and-effect questions of the general form: is X a cause of Y? If so, how large is the causal effect of X on Y? Starting from an exposition of the counterfactual model of causality, the course introduces the assumptions necessary for identifying causal effects and shows how these assumptions are justified to varying degrees in different experimental and observational research designs. As to observational studies, the course gives an overview of common and new large-N methods for causal inference, such as regression and panel estimators, matching, instrumental variable and control function approaches. The course also discusses how the principles and methods introduced may be put to good use for small-N studies, in particular when it comes to intentional case selection, and how methods frequently dubbed qualitative (such as process tracing) may help identifying the mechanisms underlying causal effect estimates. The course's primary aim is to provide students with the epistemological and methodological tools to critically evaluate existing empirical studies, to identify their inferential weaknesses, and to develop research designs on their own that, to the greatest possible extent, respond to these problems.			
Teaching Methods Hours per Week		Lecture (2 hours) and tutorial (2 hours)			
Workload		270 hours			
Type of Assessment		Final exam, active participation			
Recommended Background					
Language		English			
Frequency Offered		Winter semester			
Recommended Semester		1			
Compulsory / Optional		The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee			
Department		Department of Politics and Public Administration			

Empirie: Quantitative Methoden

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Das Modul vermittelt grundlegende Kenntnisse im Bereich der Statistik und der sozialwissenschaftlichen Forschungsmethoden. Ziel ist die Vermittlung von wissenschaftstheoretischen Grundlagen, wichtigen Forschungsdesigns, und die Erhebungs- und Auswertungstechniken der empirischen Sozialforschung (quantitativ). Die Studierenden werden befähigt, grundlegende Methoden auf neue Frage- und Aufgabenstellungen zu übertragen und sie erlernen die Planung empirischer Untersuchungen, die Konstruktion von Erhebungsinstrumenten, die Datenauswertung und die Präsentation der Ergebnisse.				
Content of Teaching	In der Veranstaltung werden grundlegende Kenntnisse der quantitativen empirischen Sozialforschung vermittelt. Im Mittelpunkt stehen die einzelnen Phasen des Forschungsablaufs von den wissenschaftstheoretischen Grundlagen bis hin zur Datenerhebung und -auswertung. Dabei wird ein Überblick über mögliche Erhebungsmethoden und Forschungsdesigns, wie Befragungen, Beobachtungen oder Experimente gegeben und auf deren Anwendungsbereich eingegangen.				
Teaching Methods Hours per Week	Vorlesung (2 SWS) mit Übung (2 SWS)				
Workload	180 Stunden				
Type of Assessment	Klausur				
Recommended Background					
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Subject Area 1 is individually scheduled for each student by the admissions committee.				
Department	Department of Sociology				

Methoden I

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	5 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Die Studierenden besitzen ein Basiswissen in Methodenlehre und Experimentalpsychologie. Sie erlangen Kenntnisse im praktischen Experimentaldesign und der Auswertung experimentell gewonnener Daten. Dabei können sie unter anderem Strategien zur Aufgabenlösung und Auswertung von Informationen entwickeln und anwenden.				
Content of Teaching	Wissenschaftstheoretische Grundlagen; Psychologie als Wissenschaft; Formen der Datenerhebung; vom Umgang mit Versuchspersonen; vom Umgang mit der Literatur; das Experiment: Labor-, Feld- und Web-Experimente, Quasi- Experimente; Untersuchungsdesign und Versuchsaufbau (u.a. mit dem Tool WEXTOR: wextor.org); Fragebogenkonstruktion; Durchführung einer Datenerhebung: Idee, Design, Pilotierung, Auswertung, Interpretation, Bericht; Internet-basierte Forschung; multi-methodische Forschungsstrategie; ethische Fragen bei der Durchführung von Untersuchungen.				
Teaching Methods Hours per Week	Vorlesung (2 SWS) mit Übung (1 SWS)				
Workload	150 Stunden				
Type of Assessment	Klausur				
Recommended Background					
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Psychology				

Methoden II

Applicability *Foundations of Data Science / Social-scientific Methods*					
Credits	5 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Die Studieren lernen grundlegende Verfahren und Begriffe der Statistik kennen und vertiefen ihr Wissen im Bereich der psychologischen Methodenlehre. Sie sind in der Lage, Daten zu erheben und mittels statistischer Verfahren grundlegende Analysen durchzuführen. Die Studierenden können Strategien zur Aufgabenlösung entwickeln und anwenden Im Bereich der Methodenlehre verbessern die Studierenden ihr methodisches Denken und ihre Argumentationsfähigkeit durch kritische Reflexion der methodischen Herausforderungen in der psychologischen Forschung.				
Content of Teaching	Wissenschaftstheorie (science of science), Beobachtung und digitale Beobachtung, Fragebogenkonstruktion, Online-Befragung, Experiment (Feldexperiment, Laborexperiment, Internet-basiertes Experiment), Non-reaktive Datenerhebung, Big Data mining (inklusive Twitter, Google Trends, Ngram), Logdateianalyse, Social Media: Psychologische Untersuchungen mit Hilfe von Facebook, SocialLab, mobile Experience Sampling Methodology, Versuchspersonenrekrutierung, apparative Hilfe, ethisch-praktische Fragen der Datenerhebung und -auswertung. Aufgabenlösung entwickeln und anwenden.				
Teaching Methods Hours per Week	Vorlesung (2 SWS) mit Übung (1 SWS)				
Workload	150 Stunden				
Type of Assessment	Klausur				
Recommended Background	Methoden I				
Language	German				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Psychology				

Statistics

Statistics (Dept. of Politics and Public Administration)

Applicability *Foundations of Data Science / Statistics*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	This lecture aims to introduce fundamental knowledge, which is needed to draw inferences by using statistical models. To achieve this goal, students will learn fundamentals of probability theories, basics of statistical models, and wide variety of statistical models available to the modern empirical social science.				
Content of Teaching	This lecture introduces the foundation of statistics used in empirical social science research with a special focus on multivariate analysis:.: – Univariate analysis: frequency distributions – Discrete probability distribution – Continuous probability distribution – Inference and Hypothesis testing – Significance testing – Bivariate analysis – Basics of confounding variable – Multiple regression – Multivariate analysis				
Teaching Methods Hours per Week	Lecture (4 SWS) and tutorial (2 SWS)				
Workload	270 hours				
Type of Assessment	Final exam.				
Recommended Background	Empirical research methods				
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Politics and Public Administration				

Statistics I (Dept. of Economics)

<table>
<tr><td colspan="6">Applicability
Foundations of Data Science / Statistics</td></tr>
<tr><td>Credits</td><td>6 Cr</td><td>Duration</td><td>1. Sem.</td><td>Module Contribution to the Final Grade</td><td>*</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">The lecture offers an introduction to statistical analysis. Topics covered include univariate and multivariate descriptive methods, explorative methods, probability, discrete and continuous random variables and their distributions. Tutorials complement the lecture and include a discussion of output from the statistical software STATA.</td></tr>
<tr><td>Content of Teaching</td><td colspan="5">• Introduction
• Sampling and Sampling Distributions
○ Law of Large Numbers
○ Central Limit Theorem
• Parameter Estimation
○ Point Estimation
○ Properties of Estimators
○ Interval Estimation
• Hypotheses Testing
○ Principles of Statistical Testing
○ Specific Statistical Tests
• Regression Analysis
○ Simple Linear Regression
▪ Model
▪ Estimation
▪ Parameter Tests
▪ Residual Analysis
▪ Prediction</td></tr>
<tr><td>Teaching Methods Hours per Week</td><td colspan="5">Lecture (2 hours) and tutorial (2 hours)</td></tr>
<tr><td>Workload</td><td colspan="5">180 hours</td></tr>
<tr><td>Type of Assessment</td><td colspan="5">Final exam + several homework tasks (graded).</td></tr>
<tr><td>Recommended Background</td><td colspan="5">College-level background in calculus including univariate integration and differentiation, partial differentiation, and multivariate integration</td></tr>
<tr><td>Language</td><td colspan="5">English</td></tr>
<tr><td>Frequency Offered</td><td colspan="5">Summer semester</td></tr>
<tr><td>Recommended Semester</td><td colspan="5">2</td></tr>
<tr><td>Compulsory / Optional</td><td colspan="5">The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee</td></tr>
<tr><td>Department</td><td colspan="5">Department of Economics</td></tr>
</table>

Statistik I (Dept. of Psychology)

<table>
<tr><td colspan="6">Applicability
Foundations of Data Science / Statistics</td></tr>
<tr><td>Credits</td><td>6 Cr</td><td>Duration</td><td>1. Sem.</td><td>Module Contribution to the Final Grade</td><td>*</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">Die Studierenden:
kennen die Grundlagen und Grundbegriffe der Methodologie und Methodik
können einen Zusammenhang herstellen zwischen verschiedenen Spezialgebieten der psychologischen Methodenlehre untereinander sowie mit substanzwissenschaftlichen Inhalten der Psychologie
verbessern ihr methodisches Denken und ihre Argumentationsfähigkeit
können Strategien zur Aufgabenlösung entwickeln und anwenden
können besser planen und Probleme lösen
orientieren sich auf Anwendungen
sind leistungsbereit, frustrationstolerant und belastbar.</td></tr>
<tr><td>Content of Teaching</td><td colspan="5">Die Lehrveranstaltung behandelt sowohl deskriptive/beschreibende Analysen als auch inferenzstatistische Verfahren. Es werden folgende Verfahren vorgestellt: Korrelationen, Häufigkeitstests, t-Tests als auch einige nicht-parametrische Verfahren. Neben der Übung finden auch Tutorien statt.</td></tr>
<tr><td>Teaching Methods Hours per Week</td><td colspan="5">Vorlesung (2 SWS) mit Übung (2 SWS)</td></tr>
<tr><td>Workload</td><td colspan="5">180 Stunden</td></tr>
<tr><td>Type of Assessment</td><td colspan="5">Schriftliche Klausur</td></tr>
<tr><td>Recommended Background</td><td colspan="5"></td></tr>
<tr><td>Language</td><td colspan="5">German</td></tr>
<tr><td>Frequency Offered</td><td colspan="5">Winter semester</td></tr>
<tr><td>Recommended Semester</td><td colspan="5">1</td></tr>
<tr><td>Compulsory / Optional</td><td colspan="5">The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee</td></tr>
<tr><td>Department</td><td colspan="5">Department of Psychology</td></tr>
</table>

Statistik (Dept. of Sociology)

Applicability *Foundations of Data Science / Statistics*					
Credits	6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Das Modul vermittelt grundlegende Kenntnisse im Bereich der Statistik. Ziel ist die Vermittlung von wissenschaftstheoretischen Grundlagen für die Anfertigung von Forschungsarbeiten				
Content of Teaching	In der Veranstaltung wird eine Einführung in die sozialwissenschaftliche Statistik anhand von überwiegend soziologischen Anschauungsbeispielen und Übungsaufgaben gegeben. Behandelt werden sowohl die Grundlagen der Wahrscheinlichkeitstheorie, als auch die deskriptive Statistik und die Inferenzstatistik. Dabei werden univariate, bivariate und multivariate Maßzahlen erläutert und auf geeignete graphische Darstellungen eingegangen. Dies beinhaltet sowohl Zusammenhangsmaße für Variablen mit unterschiedlichem Skalenniveau als auch Regressionsanalysen (OLS).				
Teaching Methods Hours per Week	Vorlesung (2 SWS) mit Übung (2 SWS)				
Workload	180 Stunden				
Type of Assessment	Schriftliche Klausur				
Recommended Background					
Language	German				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	The selection of courses in Foundation of Data Sciences is individually scheduled for each student by the admissions committee				
Department	Department of Sociology				

Subject Area 2: Advanced Methods: Computer Science

Big Data Management and Analysis

Applicability *Subject Area 2: Advanced Methods: Computer Science*					
Credits	6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	The students know and understand the basic concepts for dealing with very large data sets and are able to apply them in small projects.				
Content of Teaching	The term "big data" is often used to describe vast collections of semi-structured data in the range of tera- or even petabytes. Companies like Google and Amazon illustrate that mining and analyzing such collections yields the potential for completely new applications. The lecture provides an overview of motivations to analyze big data and introduces techniques needed in the process. This includes introductions to scripting languages, NoSQL databases and Map/Reduce systems which are accompanied by practical exercises. Content overwiew: • Streaming Synopses • Stream Clustering • NoSQL Systems • Large-scale Data Storage and Processing For implementations the students are free to use a programming language of their choice.				
Teaching Methods Hours per Week	Lecture (2 hours) and tutorial (2 hours)				
Workload	180 hours				
Type of Assessment	Students have to pass 50% of the weekly theoretical and practical assignments and a written exam at the end of the semester				
Recommended Background	Principles of Computer Science and Programming Course I, Database Systems				
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Computer and Information Sciences				

Algorithmen und Datenstrukturen + Programmierkurs II

Applicability *Subject Area 2: Advanced Methods: Computer Science*					
Credits	9 + 3 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Absolventinnen und Absolventen haben grundlegende Kenntnis elementarer Algorithmen und Datenstrukturen. Sie sind in der Lage Korrektheitsbeweise und Komplexitätsabschätzungen durchzuführen, sowie neue Algorithmen und Datenstrukturen für gegebene Anwendungsszenarien zu entwerfen. Zudem erweben Sie die Fähigkeit, elementare Algorithmen und Datenstrukturen so zu implementieren, dass diese in Form von Bibliotheken wiederverwendet werden können.				
Content of Teaching	In der Vorlesung werden Standardalgorithmen und grundlegende Datenstrukturen vorgestellt. Dabei werden insbesondere Korrektheit und Komplexität von Algorithmen untersucht. Zudem werden Darstellungsformen und Spezifikation von Algorithmen, elementare und höhere Datenstrukturen, Suchbäume, Hash-Tabellen, rekursive Algorithmen, Algorithmen zum Suchen und Sortieren, sowie grundlegende Graphenalgorithmen und Zeichenkettenalgorithmen behandelt. Im zugehörigen Programmierkurs werden dann ausgewählte Algorithmen und Datenstrukturen implementiert mit einem Fokus auf Wiederverwendbarkeit und Benutzbarkeit des Codes im Rahmen größerer Projekte.				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS) + (2 SWS)				
Workload	270 Stunden + 90 Stunden				
Type of Assessment	Klausur. Erfolgreiche Teilnahme an den Übungen ist Voraussetzung für die Zulassung zur Klausur.				
Recommended Background					
Language	German				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Computer and Information Sciences				

Datenbanksysteme

Applicability *Subject Area 2: Advanced Methods: Computer Science*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Die Absolventinnen und Absolventen haben fundiertes Wissen über konzeptionelle Datenmodellierung mit Hilfe des Entity-Relationship-Modells und die Abbildung auf relationale Datenbankschemata. Sie können die grundlegenden Sprachkonstrukte von SQL mittels mathematisch präziser formaler Sprachen (Algebra, Kalkül) analysieren und können SQL-Anfragen und -Änderungsoperationen selbstständig formulieren und anwenden. Sie haben die prinzipiellen Realisierungstechniken solcher deklarativer Sprachen kennen gelernt und können bestehende SQL-Anwendungen analysieren und bewerten. Sie sind in der Lage, grundlegende Informationssystem-Funktionalitäten selbständig zu realisieren. Die Funktionsweise und Abstraktionsmechanismen der transaktionsorientierten Verarbeitung sind ihnen bekannt, sie können Synchronisations- und Recovery-Probleme erkennen und grundsätzliche Lösungsmöglichkeiten aufzeigen.				
Content of Teaching	Die Veranstaltung vermittelt einen grundlegenden Überblick über Funktionalität, Architektur und Realisierungskonzepte von Datenbanksystemen als Grundlage für computergestützte Informationssysteme. Charakteristisch für Datenbanksysteme ist, dass Informationen gemäß irgendeinem Modell in strukturierter Form dargestellt, gespeichert und aufbewahrt werden, die mittels Operationen einer geeigneten Sprache abgefragt (wiedergewonnen) und manipuliert werden können. Im Vordergrund stehen die Schnittstellen, d.h. die Nutzersicht, Implementierungsaspekte werden nur angerissen. In dieser Veranstaltung werden sowohl die Modellierungs- wie auch die Nutzungsaspekte von Datenbanksystemen vermittelt: z.B. Entity-Relationship- und Relationale Datenmodellierung, Relationale Entwurfstheorie und Normalformen, Datenbanksprachen (insbes. Algebra, Kalkül, SQL), ACID-Transaktionen. Die Lehrveranstaltung liefert Grundlagen für weiterführende Lehrveranstaltungen aus den Gebieten Datenbanken, Informationssysteme und Information Retrieval.				
Teaching Methods Hours per Week	Lecture (4 hours) and tutorial (2 hours)				
Workload	270 Stunden				
Type of Assessment	Klausur von 120 min Dauer. Die erfolgreiche Teilnahme an den Übungen ist Voraussetzung für die Zulassung zur Klausur. Die Note ergibt sich aus der Klausurnote.				
Recommended Background	Grundlegende Kenntnisse in Aussagen- und Prädikatenlogik (z.B. Diskrete Mathematik und Logik oder Konzepte der Informatik, elementare Programmierkenntnisse)				

Language	German/English (lecture slides)
Frequency Offered	Summer semester
Recommended Semester	2
Compulsory / Optional	optional
Department	Department of Computer and Information Sciences

Konzepte der Programmierung + Programmierkurs III

Applicability *Subject Area 2: Advanced Methods: Computer Science*					
Credits	6 + 6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Absolventinnen und Absolventen haben ein grundlegendes Verständnis von Programmierparadigmen und von funktionaler Programmierung. Sie sind in der Lage, selbständig kleinere Projekte in Haskell zu definieren und zu implementieren. Konzepte von Programmiersprachen sollen bewusst gemacht werden.				
Content of Teaching	Das Modul besteht aus der Vorlesung „Konzepte der Programmierung“ und dem „Programmierkurs 3“ (deklarative Sprache). Kern des Moduls ist eine Einführung in deklarative Programmierung. Im Unterschied zur imperativen Programmierung wird dabei durch die Programmiererin/den Programmierer idealerweise nur vorgegeben, was berechnet werden soll, aber nicht wie genau die Berechnung durchgeführt wird. Am Beispiel der rein funktionalen Programmiersprache Haskell soll dieses Konzept eingeführt werden. Dabei werden Konzepte wie z. B. Seiteneffekte, Typsysteme, Auswertestrategien und Datenstrukturen erläutert und aus formaler Sicht betrachtet. Mit einer Einführung in den lambda-Kalkül wird die einfachste formale Grundlage fast aller Programmiersprachen vorgestellt, viele Haskell-Konstrukte lassen sich leicht darauf zurückführen. Vorlesungsbegleitend gibt der „Programmierkurs 3“ eine praktische Einführung in die Programmierung mit Haskell. Da Vorlesung und Programmierkurs inhaltlich sehr eng verzahnt sind, werden die Übungen zu beiden Veranstaltungen zusammengelegt.				
Teaching Methods Hours per Week	Vorlesung (4 SWS) mit Übung (2 SWS) + (2 SWS)				
Workload	180 Stunden + 150 Stunden				
Type of Assessment	Leistungsnachweis: schriftliche Prüfung Erfolgreiche Teilnahme an den Übungen ist Voraussetzung für die Zulassung zur Prüfung.				
Recommended Background					
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	3				
Compulsory / Optional	optional				
Department	Department of Computer and Information Sciences				

Subject Area 3: Advanced Methods: Statistics

Advanced Econometrics

Applicability *Subject Area 3: Advanced Methods: Statistics*					
Credits	10 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	On completion of this module, students will be able to: • Demonstrate a sound understanding of econometric estimation theory beyond the linear model • Demonstrate an awareness of major estimation methods and testing principles for nonlinear econometric models • Programing with Python in order to understand the applied aspects of estimation principles and to apply modern econometric estimators, which are not available in standard commercial software packages				
Content of Teaching	• Asymptotic theory • Instrumental variables • Maximum likelihood and Pseudo-ML • Generalized method of moments • Computer Intensive Methods • Shrinkage Estimation				
Teaching Methods Hours per Week	Lecture (3 hours) and tutorial (2 hours)				
Workload	300 hours				
Type of Assessment	One mid-term exam (20 %), two take-home exams (10% each) and a final exam (60%)				
Recommended Background	Econometrics I				
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	1				
Compulsory / Optional	optional				
Department	Department of Economics				

Probability Theory and Statistical Inference

<table>
<tr><td colspan="6">Applicability
Subject Area 3: Advanced Methods: Statistics</td></tr>
<tr><td>Credits</td><td>9 Cr</td><td>Duration</td><td>1. Sem.</td><td>Module Contribution to the Final Grade</td><td>*</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">The course covers the major topics from probability theory and statistical inference that lay the grounds for econometric theory. It conveys a proper understanding of the basic theoretical concepts and ideas needed to work in applied and theoretical econometrics.</td></tr>
<tr><td>Content of Teaching</td><td colspan="5">The course gives an introduction to the basic mathematical foundations of probability theory and of statistical inference on a graduate level. The foundations of probability theory part of the course cover the following topics:
– Basics of probability theory:
a. events, probability, conditional probability, independence, product spaces and completeness;
b. discrete and continuous random variables, probability distributions;
c. expectation, conditional expectation, conditional distributions;
d. moment generating and characteristic functions, their applications.
– Basics of asymptotic theory:
a. convergence concepts, modes of convergence;
b. limit theorems.
The statistical inference part of the course covers the following topics:
1) Random sample, properties;
2) Principles of data reduction, the sufficiency and the likelihood principles;
3) Point estimation, finding and evaluating point estimators;
4) Interval estimation, finding and evaluating interval estimators;
5) Estimation theory for parametric models: regression models and least squares method.</td></tr>
<tr><td>Teaching Methods Hours per Week</td><td colspan="5">Lecture (2 hours) and tutorial (2 hours)</td></tr>
<tr><td>Workload</td><td colspan="5">240 hours</td></tr>
<tr><td>Type of Assessment</td><td colspan="5">Tutorials (15%), 2 home assignments (15%), 1 midterm exam (30%), final exam (40%)</td></tr>
<tr><td>Recommended Background</td><td colspan="5">Solid mastery of calculus, up to and including series, limits, partial differentiation, and multiple integration. Knowledge of these topics will be assumed and invoked freely. Basic knowledge of statistics is required.</td></tr>
</table>

Language	English
Frequency Offered	Summer semester
Recommended Semester	1
Compulsory / Optional	optional
Department	Department of Economics

Applied Econometrics and Machine Learning

(instead of Microeconometrics)

Applicability *Subject Area 3: Advanced Methods: Statistics*					
Credits	8 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	The goal of this seminar is to acquaint students with the necessary toolbox of machine learning techniques. Students have to write an empirical research paper in which they apply a novel and/or advanced method to shed more light on a real world problem.				
Content of Teaching	Modern empirical research in economics and finance uses computer intensive methods for the analysis of complex data sets. The estimates are based on algorithmic methods to cope with a whopping numbers of covariates and possible model specifications. The problem is prevalent e.g. in macroeconomic forecasting, in financial econometrics (e.g. portfolio and risk management), and in the evaluation of causal treatment effects of public policies. Consequently, empirical studies in economics and finance rely more and more on machine learning techniques (e.g. lassoing, support vector machines, artificial neuronal nets).				
Teaching Methods Hours per Week	Lecture (3 hours) and tutorial (1 hours)				
Workload	240 hours				
Type of Assessment	Final exam				
Recommended Background	Econometrics I and Advanced Econometrics (or equivalent). Participation in the lecture Applied Econometrics is a advantage. We expect that students have a decent programming background in either MatLab, R or Python or at least willing to invest sufficient effort to learn one of these languages.				
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Economics				

Research Design II: Statistical Modelling and Inference

Applicability *Subject Area 3: Advanced Methods: Statistics*					
Credits	9 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	At the end of this course students will have a solid understanding of model-based inference. They will be able to implement maximum likelihood estimators of their own choosing, understand and interpret their estimation results. They will also be familiar with concepts that form the basis of other important statistical approaches such as latent variable modeling, random utility modeling, or Bayesian statistics.				
Content of Teaching	This course deals with maximum likelihood estimation (MLE), one of the most important statistical methods, applied in diverse political science studies. Understanding their basic idea and implementation facilitate a more conscious handling of empirical information, based on statistical models and the assumed stochastic processes. The course provides theoretical as well as practical knowledge (acquired during supplementary computer lab sessions) on how to use maximum likelihood estimation in applied political science research. The course also highlights important issues in model specification, identification, and interpretation of results.				
Teaching Methods Hours per Week	Lecture (2 hours) and tutorial (2 hours)				
Workload	270 hours				
Type of Assessment	Weekly (ungraded) short quizzes; final in-class exam				
Recommended Background	Statistics I				
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	1				
Compulsory / Optional	optional				
Department	Department of Politics and Public Administration				

Applied Time Series Analysis

Applicability *Subject Area 3: Advanced Methods: Statistics*					
Credits	8 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Many economic variables are observed over time on a regular frequency (e.g. the quarterly growth rate of GDP, the monthly CPI inflation rate, daily interest rates, daily returns of the DAX stock market index). This type of data is known as time series data and often features correlation over time that can be exploited for forecasting. In this course econometric models for univariate time series data are introduced. Estimation and model specification as well as their use in forecasting is discussed in the lecture. Students learn how to apply these methods in practice during the computer session using the popular econometric software Matlab.				
Content of Teaching	1. Introduction and Descriptive Methods 2. Stationary Stochastic Processes (AR, MA, ARMA) 3. Estimation, Specification and Validation of ARMA models 4. Nonstationary Processes (ARIMA, Unit Root Tests) 5. Forecasting 6. Time Series Models of Heteroskedasticity (ARCH + GARCH Processes) 7. Topics in Applied Time Series Modelling				
Teaching Methods Hours per Week	Lecture (3 hours) and tutorial (1 hour)				
Workload	240 hours				
Type of Assessment	Exam				
Recommended Background	Bachelor level econometrics				
Language	English				
Frequency Offered	Summer Semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Economics				

Advanced Time Series Analysis

Applicability *Subject Area 3: Advanced Methods: Statistics*					
Credits	8 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	On completion of this module, students will be able to: • Use a range of methods to analyse multiple time series data • Use and program standard econometric software to analyse time series data • Critically discuss and interpret the results of empirical time series related research papers.				
Content of Teaching	Emphasis is given on the vector autoregressive framework, which is very popular in empirical macroeconomics and finance. The course covers the analysis of stable vector autoregressive (VAR) models, as well as the statistical analysis of integrated and cointegrated variables. Further topics to be discussed include recent advances in structural VAR modelling, panel unit roots and cointegration, factor augmented VARs, time-varying parameters and Bayesian VARs. • Stable vector autoregressive (VAR) models • Integrated variables and cointegrated VAR models • Structural VARs and VECMs • Unit roots and cointegration in panels • Time-varying parameters and Bayesian VARs • Multivariate GARCH models				
Teaching Methods Hours per Week	Lecture (3 hours) and tutorial (1 hour)				
Workload	240 hours				
Type of Assessment	One mid-term exam (20 %), two take-home exams (20%) and a final exam (60%).				
Recommended Background	• Advanced Econometrics • Applied Time Series Analysis				
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	3				
Compulsory / Optional	optional				
Department	Department of Economics				

Subject Area 4: Programming and Scripting

Data Analysis with R

Applicability *Subject Area 4: Programming and Scripting*					
Credits	7 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	**not graded**
Learning Outcomes	At the end of this course you will be able to work with data in R and conduct statistical analyses.				
Content of Teaching	This course is about how to use R in analyzing data. The first part of the course introduces the grammar of R. The second part demonstrates the use of R in conducting statistical analyses of social science data. The third part introduces important techniques for processing and managing data sets with R.				
Teaching Methods Hours per Week	Lecture (2 hours)				
Workload	210 hours				
Type of Assessment	Weekly exercises; one take-home assignment; final in-class exam				
Recommended Background					
Language	English				
Frequency Offered	Every semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Politics and Public Administration				

Datenanalyse mit R

Applicability *Subject Area 4: Programming and Scripting*					
Credits	7 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	**not graded**
Learning Outcomes	At the end of this course you will be able to work with data in R and conduct statistical analyses.				
Content of Teaching	This course is about how to use R in analyzing data. The first part of the course introduces the grammar of R. The second part demonstrates the use of R in conducting statistical analyses of social science data. The third part introduces important techniques for processing and managing data sets with R.				
Teaching Methods Hours per Week	Lecture (2 hours)				
Workload	210 hours				
Type of Assessment	Weekly exercises; one take-home assignment; final in-class exam				
Recommended Background					
Language	German				
Frequency Offered	Every semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Politics and Public Administration				

Programmierkurs I

Applicability *Subject Area 4: Programming and Scripting*					
Credits	6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	**not graded**
Learning Outcomes	Die Absolventinnen und Absolventen haben ein grundlegendes Verständnis der imperativen und objektorientierten Programmierung mit Java. Grundlegende Modellen können selbstständig implementiert werden.				
Content of Teaching	• Objektorientierte Programmierung: die in der Vorlesung „Konzepte der Informatik“ vorgestellten Konzepte objektorientierter Programmiersprachen wie Klassen, Vererbung, Polymorphismus, Ausnahmebehandlung oder generische Programmierung werden praktisch mit Java an Hand verschiedenster Beispiele geübt • Imperative Programmierung: Befehlsorientierte Programmierung mit Methoden, Schleifen und Auswahlbefehle • Angewandte Programmierung: Programmqualität, Dokumentation und Testen von Programmen				
Teaching Methods Hours per Week	Lecture (2 hours)				
Workload	180 Stunden				
Type of Assessment	Nur unbenotete Studienleistung möglich (>60% der Punkte aus den Übungen, >70% des Projektes bearbeitet)				
Recommended Background					
Language	German				
Frequency Offered	Every semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Computer and Information Science				

Programmierkurs II

Applicability *Subject Area 4: Programming and Scripting*					
Credits	3 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	not graded
Learning Outcomes	Die Studenten erwerben die Fähigkeit, elementare Algorithmen und Datenstrukturen so zu implementieren, dass diese in Form von Bibliotheken wiederverwendet werden können.				
Content of Teaching	Im Programmierkurs werden ausgewählte Algorithmen und Datenstrukturen aus der dazugehörigen gleichnamigen Vorlesung implementiert mit einem Fokus auf Wiederverwendbarkeit und Benutzbarkeit des Codes im Rahmen größerer Projekte.				
Teaching Methods Hours per Week	Lecture (2 hours)				
Workload	90 Stunden				
Type of Assessment	Erfolgreiche Teilnahme ist Zulassungsvoraussetzung für die Klausur Algorithmen und Datenstrukturen.				
Recommended Background	Programmierkurs I				
Language	German				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory / Optional	optional				
Department	Department of Computer and Information Science				

Programmierkurs III

Applicability *Subject Area 4: Programming and Scripting*					
Credits	6 Cr	**Duration**	1. Sem.	**Module Contribution to the Final Grade**	**not graded**
Learning Outcomes	Für fortgeschrittene Programmierung in der Linux / Unix-Umgebung ist es wichtig, die Dienste des Linux-Kernels (System Calls) und der C-Bibliothek zu kennen. Zu den Themen gehören File, Buffered und Advanced I/O (z. B. scatter / gather, poll, memory mapped I/O), Prozessmanagement, Datei- und Verzeichnisverwaltung, Speicherverwaltung, Signale und Zeitfunktionen. Themen sind die Entwicklung von Linux-Kernel-Modulen und einfachen Gerätetreibern. Aspekte wie Kernel-Threads und grundlegende Kernstrukturen werden diskutiert.				
Content of Teaching	Der Programmierkurs „Systemnahe Programmierung“ betrachtet anhand von Unix/Linux Betriebssysteme aus einer praktischen Perspektive heraus. Der Programmierkurs beinhaltet: 1. Die Programmiersprache C 2. Systemnahe Programmierung in Linux Die Inhalte sind: Einführung in die Programmiersprache C, Zeigerarithmetik, Präprozessor, "make"; einfaches I/O, Prozesssteuerung, IPC über Pipes, Shared Memory, Socket und Signale; Synchronisation mit Semaphoren, Linker, Relocation, statische und dynamische Bibliotheken.				
Teaching Methods Hours per Week	Lecture (2 hours)				
Workload	150 Stunden				
Type of Assessment	Schriftliche Prüfung wie angegeben in "Konzepte der Programmierung"				
Recommended Background	Gleichzeitiger Besuch von “Konzepte der Programmierung”				
Language	German				
Frequency Offered	Winter semester				
Recommended Semester	3				
Compulsory / Optional	optional				
Department	Department of Computer and Information Science				

Subject Area 5: Social Science Applications

Computational Social Science Seminar

Applicability *Subject Area 5: Social Science Applications*					
Credits	7 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Students know core research areas in the field of computational social science, are familiar with key conceptual and methodological approaches and can apply them in their own research.				
Content of Teaching	It covers four core research areas in the field: automated data extraction, social complexity, computational simulations and social network analysis. Each topic is introduced over several sessions. Assigned readings cover foundational work and key methodological contributions as well as current examples from social science research. The course highlights technical strengths and limitations of the various approaches introduced. It also critically reflects on where and how specific computational approaches can contribute to answering substantial social science research questions. It further provides an overview of existing tools implementing the various approaches discussed. As part of the seminar, students pursue an independent research project using computational social science approaches. There are no strict formal prerequisite requirements for this course but good programming skills and a strong background in (quantitative) research methods and statistics are expected.				
Teaching Methods Hours per Week	Seminar (2 hours)				
Workload	210 hours				
Type of Assessment	Independent research project and corresponding seminar thesis. Successful participation in the lecture and submission of a minimum of three response papers during the term is required to receive credits in the course.				
Recommended Background					
Language	English				
Frequency Offered	Winter semester				
Recommended Semester	3				
Compulsory/optional	optional				
Department	Department of Politics and Public Administration				

Using Digital Trace Data in the Social Sciences

Applicability *Subject Area 5: Social Science Applications*					
Credits	7 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	Over the course, students will learn fundamental techniques of data collection preparation, and analysis with digital trace data in the social sciences. In this, we will focus on working with the microblogging-service Twitter. Over the course, students are expected to become proficient in the use of two programming languages, Python and R.				
Content of Teaching	We will start the course by focusing on conceptual issues associated with the work with digital trace data. You will then learn to use fundamental practices in the use of the programming language Python. Following this, we will collect data from Twitter's APIs through a set of example scripts written in Python. After downloading data from Twitter through Python, we will load these data into a SQLite database for ease of access and flexibility in data processing tasks. Finally, we will discuss a series of typical analytical procedures with Twitter-data. Here, we will focus on counting entities and establishing their relative prominence, time series analysis, and basic approaches to network analysis. For these analyses, we will predominantly rely on R.				
Teaching Methods Hours per Week	Seminar (hours)				
Workload	210 hours				
Type of Assessment	Term Paper, Active Participation, Presentation				
Recommended Background					
Language	English				
Frequency Offered	Summer semester				
Recommended Semester	2				
Compulsory	optional				
Department	Department of Politics and Public Administration				

Data Science Project

Applicability *Subject Area 5: Social Science Applications*					
Credits	6 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	*
Learning Outcomes	The data science project offers students the possibility to implement different, advanced techniques of analysis to address a given problem.				
Content of Teaching	The data science project provides students with the opportunity to work through a project from its conceptualization scratch down to its (software) implementation. Co-operations with external partners (firms, governmental and non-governmental organizations) are encouraged. The data science project constitutes an innovative teaching format, with a strong focus on applying the statistical and computational methods previously acquired.				
Teaching Methods Hours per Week	Independent work upon agreement with a Principal Investigator at the Graduate School of Decision Sciences				
Workload	180 hours				
Type of Assessment	Data Science Project report and presentation				
Recommended Background	Relevant courses and seminars of the Master's programme				
Language	English				
Frequency Offered	Every semester				
Recommended Semester	3				
Compulsory / Optional	Optional				
Department	All participating departments				

Internship

Applicability *Subject Area 5: Social Science Applications*					
Credits	6 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	**not graded**
Learning Outcomes	Gather relevant hands-on experience in a private or public body that is strictly involved in the analyses of data, production of statistical reports, etc.				
Content of Teaching	The internship must serve the study goal				
Teaching Methods Hours per Week	Minimum duration: 6 weeks				
Workload	180 hours				
Type of Assessment	Internship must be approved before the start, confirmation of completion from employer				
Recommended Background	Relevant courses and seminars of the Master's programme				
Language	English/German				
Frequency Offered	Every semester				
Recommended Semester	3				
Compulsory / Optional	Optional				
Department					

Subject Area 6: Master's Thesis

Applicability *Subject Area 6: Master's Thesis*					
Credits	24 Cr	**Duration**	4 months	**Module Contribution to the Final Grade**	22%
Learning Outcomes	On completion of this module, students will be able to: – Develop a research proposal – Synthesise knowledge and skills previously acquired and applied to an in-depth study – Establish links between theory and methods within their area of study – Present the findings of their research in a coherent and logically argued piece of writing that demonstrates competence in research and the ability to operate independently.				
Content	The aim of the Master's thesis is to demonstrate that the student is in a position to independently analyse and assess a topic from the field of social science data analysis, within a prescribed time period and using scientifically recognised methods. Students select their own topic for the thesis in consultation with their supervisor.				
Supervisor	Each student selects two reviewers for the thesis, who can be professors or junior professors of the participating departments. At least one reviewer has to be Principal Investigator of the Graduate School of Decision Sciences.				
Teaching Methods	The theoretical and methodological background knowledge for conducting a thesis is acquired through the compulsory and optional subject areas of the Master's programme. Practise in the completion of research papers is obtained in the seminars of the Master's programme.				
Workload	720 hours				
Type of Assessment	The average grade of the two assessments of the Master's thesis.				
Recommended Background	The relevant courses and seminars of the Master's programme				
Language	English				
Frequency Offered	Summer semester (Winter semester optional)				
Recommended Semester	4				
Compulsory / Optional	compulsory				
Department	All participating Departments				

MA-Colloquium

Applicability *Subject Area 6: Master's Thesis*					
Credits	3 Cr	**Duration**	1 Sem.	**Module Contribution to the Final Grade**	2.78%
Learning Outcomes	Students have the opportunity to improve their presentation techniques. Furthermore, an in-depth treatment of political and economic theories and methods is carried out using the example of Master's candidates' concrete projects.				
Content of Teaching	The Master's candidates' mandatory participation in appropriate colloquia conduces to the intensive preparation and supervision of the Master's Thesis. In the MA-Colloquium question, research design and approach of every assignment are discussed with the supervisor and other candidates.				
Workload	90 hours				
Type of Assessment	Oral Presentation				
Language	English				
Frequency Offered	Summer semester (Winter semester otional)				
Recommended Semester	4				
Compulsory / Optional	compulsory				
Department	All participating Departments				

* The contribution from each course to the final grade is not automatically proportional to the number of ECTS credits of each course. For details regarding the calculation method refer to the MSc Social and Economic Data Science examination regulation.