KLADDE

AFLYST jf. besked fra Eline 11. maj - Parameter Estimation

Title	AFLYST jf. besked fra Eline 11. maj - Parameter Estimation
Semester	E2023
Master programme in	Mathematical Bioscience / Physics and Scientific Modelling
Type of activity	Course
Teaching language	English
Study regulation	Read about the Master Programme and find the Study Regulations at ruc.dk Læs mere om uddannelsen og find din studieordning på ruc.dk

REGISTRATION AND STUDY ADMINISTRATIVE

Registration	Sign up for study activities at stads selvbetjeningwithin the announced registration period, as you can see on the Studyadministration homepage. When signing up for study activities, please be aware of potential conflicts between study activities or exam dates. The planning of activities at Roskilde University is based on the recommended study programs which do not overlap. However, if you choose optional courses and/or study plans that goes beyond the recommended study programs, an overlap of lectures or exam dates may occur depending on which courses you choose.
Number of participants	The Master Programme/Institute reserves the right to cancel the course if fewer than 8 studentes are registered for the course.
ECTS	5
Responsible for the activity	Johnny T. Ottesen (johnny@ruc.dk)
Head of study	Jesper Schmidt Hansen (jschmidt@ruc.dk)
Teachers	

Study administration	INM Registration & Exams (inm-exams@ruc.dk)
Exam code(s)	U60168
ACADEMIC	**CONTENT**
Overall objective	The overall objective of the course is to provide students with a fundamental understanding of selected methods in the field of parameter estimation. Students will learn to apply parameter estimation critically in various biological applications, by working with empirical data and mathematical models.
Detailed description of content	Assessing parameter values for models described by non-linear ordinary differential equations is a serious challenge in all fields of science. Often the challenge is divided into two challenges. Ones regard the possibility of estimating the parameters values if perfect data was available assuming the model is correct, i.e., if pseudo-data was generated from the model, can all parameter values be uniquely obtained then? Whenever, such structural identifiability is established, the challenge of estimating the parameters from real measurement occur. This is done by specifying a criterion for obtaining the best estimates i.e., a least square cost, a more general cost function, or another way of addressing a best (optimal) estimate. This, second challenge is very diverse: Often data are given to the mathematicians, and we have not been involved in deciding of which measurement are obtained. Practical limitation of what can be measured is another challenge. However, this is a major reason for parameter estimation, since this allows us to access the otherwise inaccessible, a strategy sometimes refer to as the mathematical microscope. Moreover, data may be noisy, which leads to uncertainties on the estimated parameters. In the process of estimating parameter values mathematical methods for classical optimization or a Basian approach is often used. These comes with computational challenges such as robustness of the method and computational costs. It turns out that the choice of a 'best mathematical and computational methodology' is intricately coupled to the specific model and the available data. Thus, several different methods are needed. Whenever, all of the above is solved, the estimates and their certainties need to be interpreted in relation to the actual modeling challenge we began with while reflections on which elements in our estimation procedure could be improved. The course deals with these topics. The theoretical foundation needed to understand when and why to use which method will be central but real scientific and practical challenges will be addressed. Moreover, the state of the art of mathematical models will be applied to these real-world challenges. The

course will require good skills in linear algebra, analysis, dynamical systems, probability theory, statistics, and in Python programming.

Course material and Reading list

The course will require good skills in linear algebra, analysis, dynamical systems, probability theory, statistics, and in Python programming. The pensum will be various methods for parameter estimation (optimization), especially in relation to dynamical systems. Equal weight is on theory and application to real-world problems in mini-project.

Overall plan and expected work effort

The course is a 5 ETCS credit course, corresponding to an expected student work-load of 135 hours.

• Lectures 30 hours • Preparation time 100 hours • Question hour 4.5 hour • Oral exam 3o minutes • In total 135 hours

The 100 hours preparation time means that students in average should expect to use at least 4 hours of preparation time for each double-lecture throughout the semester. In addition, there will be six mini-project during the course where the student uses the theory in practice on real-world challenges. In the periods with mini-projects more preparation time is needed compared to the remaining period. The students is expected to use 10 hours extra per mini-project distributed over the project period (1-2 weeks).

Format

Evaluation and feedback

The course includes formative evaluation based on dialogue between the students and the teacher(s). Students are expected to provide constructive critique, feedback and viewpoints during the course if it is needed for the course to have better quality. Every other year at the end of the course, there will also be an evaluation through a questionnaire in SurveyXact. The Study Board will handle all evaluations along with any comments from the course responsible teacher. Furthermore, students can, in accordance with RUCs ‘feel free to state your views’ strategy through their representatives at the study board, send evaluations, comments or insights form the course to the study board during or after the course.

Programme

ASSESSMENT

Overall learning outcomes	The student will be able to • apply singular-value decomposition to big data sets, principal component analysis, and model selection, • critically use the concept of identifiability and evaluate methods to determine parameter identifiability to real world data and models, • critically judge the applicability of various methods for parameter estimation • show an overview of selected methods for parameter estimation, and critically and analytically explore the limitations and validity of the methods, • calculate and discuss uncertainty quantification critically. • perform case based numerical explorations using software
Form of examination	Individual written take-home assignment. The character limit of the assignment is: 1,200-120,000 characters, including spaces. The character limit includes the cover, table of contents, bibliography, figures and other illustrations, but exclude any appendices. The duration of the take-home assignment is 24 hours. Assessment: 7-point grading scale.
Form of Re-examination	Individual oral exam without time for preparation. Time allowed for exam including time used for assessment: 30 minutes. Permitted support and preparation materials: Course material and own notes. Assessment: 7-point grading scale. Moderation: Internal co-assessor.
Type of examination	

in special cases	
Examination and assessment criteria	
Exam code(s)	Exam code(s) : U60168