DUTCH NETWORK ON THE MATHEMATICS OF OPERATIONS RESEARCH (LNMB)

MASTER AND PhD PROGRAMME IN OPERATIONS RESEARCH

Information Guide 2019/2020

July 2019

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… and all members of the Executive board

Website: www.lnmb.nl

CONTENTS

Preface

The education programme of the LNMB provides high quality teaching in the broad field of interest in the mathematics of operations research, including new interesting areas. The programme consists of 24 courses for Master and PhD students. This year five Master courses and nine PhD courses are scheduled (the PhD courses have a cycle of two years). It is allowed that Master students attend PhD courses and, vice versa, that PhD students attend Master courses. The lectures are taught in the Uithof buildings of the Utrecht University.

The education programme for the academic year 2019/2020 consists of the following courses.

Master courses:
Fall 2019:
– Continuous Optimization;
– Discrete Optimization.
Spring 2020:
– Advanced Linear Programming;
– Scheduling;
– Queueing Theory.

PhD courses:
Trimester 1:
– Asymptotic Methods in Queueing Theory;
– Algorithms and Complexity;
– Interior Point Methods.
Trimester 2:
− Integer Programming Methods;
− Noncooperative Games;
− Advanced Topics in Stochastic Operations Research.
Trimester 3:
− Robust Optimization;
− Algorithmic Game Theory;
− Stochastic Programming.

Besides information about the LNMB courses, this guide contains:
− organisational and administrative affairs;
− information about the operations research groups at the Dutch universities;
− links to lists of members, PhD students and alumni.

The information is also available via the LNMB website www.lnmb.nl

In addition to the courses, the LNMB organizes the 45th Lunteren Conference on the Mathematics of Operations Research. This conference will be held 13 – 15th January 2020.

The LNMB gladly acknowledges the financial support by the universities. This enables the LNMB to continue its activities.

Johann Hurink,
Director LNMB
July, 2019

1. Dutch Network on the Mathematics of Operations Research (LNMB)

The Dutch Network on the Mathematics of Operations Research (in Dutch: Landelijk Netwerk Mathematische Besliskunde; abbreviated LNMB) is an interuniversity co-operation in which all Dutch universities and the Centre for Mathematics and Computer Science (CWI) in Amsterdam participate. The LNMB has been established in July 1987. From 1987 until 2001 the University of Groningen was its administrator, from 2002 until 2006 the University of Maastricht, and from January 2007 the University of Twente acts as administrator of the LNMB.

The tasks of the LNMB are twofold. Firstly, the LNMB offers courses for PhD and Master students, and is responsible for the annual Lunteren Conference on the Mathematics of Operations Research. Secondly, the LNMB is an organization of full and associate professors in the field of Operations Research. The universities and the CWI are represented in the General Board out of whom an Executive Board is chosen.

The LNMB has 130 members and 274 PhD students. The LNMB courses are also accessible, on payment, to other interested people. An independent judgment by NWO (Netherlands Organization for Scientific Research) has proven that the LNMB graduate education programme is of a high international standard.

2. PhD courses and diploma requirements (general information)

The programme of the LNMB PhD courses is offered in a biennial cycle consisting of 18 courses. The subjects of the courses are in the following areas: Combinatorial Optimization, Stochastic Operations Research, Mathematical Programming, Game Theory and Applications of OR.

The programme is flexible in the sense that new PhD students can start with their programme at the beginning of any trimester. Furthermore, the individual programmes can vary; each student can choose his of her own parts of the education programme. In each trimester a combination of various subjects is taught. In general one can follow each of the courses without any prerequisites of the other courses. The courses take place on Monday in Utrecht.

The courses are intended for PhD students in Operations Research. However, Master students in mathematics, econometrics or computer science who acquired enough prerequisites are also welcome. Further information can be obtained from the director of the LNMB or from the lecturers of the courses. Furthermore, government and/or business employees who want to follow a course may participate. Participants are expected to make exercises (homework) during or at the end of the course to show that they have understood the contents of the course. The credits (including for the attendance of the course) for participants who have passed the exercises successfully have been set at 4 EC per course. In case the courses are only attended (or when the exercises are not passed successfully), the workload is set at 1 EC. At the end of each course the participants receive a certificate with the grade and the credits involved.

The following regulation holds for the course fee. Participants from the departments of the Dutch universities which finance the LNMB don't pay any course fee. Other participants pay for each course a fee of 500 Euro. The director of the LNMB is authorized to grant a reduction of this fee at occurring situations.

Application to a LNMB PhD course can be done by filling in the online application form available at the website http://www.lnmb.nl/pages/courses/. PhD students who participate for the first time in LNMB courses, also have to fill in the form for new PhD Students, which can also be found on the mentioned website.

In addition to the courses, the PhD programme includes the Lunteren Conference on the Mathematics of Operations Research. During this conference prominent - usually foreign - researchers lecture on special topics or on recent research. PhD students can give a so-called PhD presentation. In such a presentation one can present his or her research results. It is preferred to give such a presentation in the 2nd or 3rd year of the PhD period. Attendance in the Lunteren Conference is credited by 1 EC.

PhD students who have sufficiently participated in the LNMB PhD programme and have given a PhD presentation receive a diploma. Here, 'sufficiently' means that they have passed at least 6 LNMB PhD courses with success, whereby one of the courses may be replaced by a course of the graduate program GP-OML and whereby in consultation with the supervisor one course may be replaced by a Master course. If PhD courses have already been taken during the Master program, these courses are also taken into consideration for the LNMB diplom and it is mentioned on the diploma that the courses are part of a Master program. Under certain circumstances the supervisor may submit a motivated request to give the diploma to a PhD student although he or she did not meet the requirement of the PhD presentation.

3. Master courses (general information)

From September 2004, the LNMB provides Master courses in Operations Research. These courses are intended for Master students in Mathematics or Econometrics who want to take one or more courses in Operations Research. Usually, the Master thesis adviser will propose or decide that a student will participate in LNMB Master courses.

Due to the small number of Master students in Operations Research at each individual university at that time, a national concentration led to an increase in efficiency. This was intitially the main purpose of the LNMB Master courses. Additional advantages were and are that this setup can help to guarantee a qualitatively high education and that the students get in contact with professors and students from other universities. The LNMB Master courses are part of the Dutch Master Programme in Mathematics, which is a coordinated programme of the Departments of Mathematics of the Dutch universities.

In each semester (Fall and Spring) two or three LNMB Master courses are given. The subjects of the courses are taken from the following areas: Mathematical Programming, Combinatorial Optimization and Stochastic Operations Research. The programme is flexible in the sense that new Master students can start with their programme at the beginning of any semester. Furthermore, the individual programmes can vary; each student can choose his of her own courses. The courses take place on Monday in Utrecht.

Although the courses are intended for Master students, PhD students are also welcome. It is up to their thesis adviser to propose or decide that a PhD student will attend such a course. Further information can be obtained from the director of the LNMB.

The students are subjected to an examination that usually will consist of making exercises during the course and also a written or oral examination. The credits for participants who have passed the examination successfully have been set by the LNMB at ***6 EC*** per course. A final decision about the credits and the grade is formally up to the university of the student.

The organisational part of the Master courses is done by the Dutch Master’s Degree Programme in Mathematics (Mastermath). Therefore, Master- as wel as PhD students have to register for the Master courses of the LNMB via the website of Mastermath (https://elo.mastermath.nl/). Mastermath distribute the results of the Master students to the corresponding universities and the PhD students get a certificate via LNMB.

4. PhD courses 2019/2020

During the academic year 2019/2020 nine courses will be taught in three trimesters; each trimester has a duration of ten weeks. Within the first nine weeks of a trimetser one lecture for each course is given; the last week can be used if a lecture has to be cancelled in the first nine weeks.

Trimester 1: (September 9 – November 11)

• Asymptotic Methods in Queueing Theory (AsQT)	Zwart
• Algorithms and Complexity (AC)	Nederlof/Schmidt
• Interior Point Methods (IPM)	de Klerk

Trimester 2: (November 18 – December 16 and January 20 – February 17)

• Integer Programming Methods (IntPM)	Spliet/Walter
• Noncooperative Games (NCG)	Staudigl/Thuijsman
• Advanced Topics in Stochastic Operations Research (ATS)	den Boer

Trimester 3: (February 24 – April 6, April 20, May 4 – May 11)

• Algorithmic Game Theory (AGT)	Schäfer
• Robust Optimization (RO)	den Hertog/de Ruiter
• Stochastic Programming (SP)	Romeijnders

The courses are given on Monday according to the following schedule:

	Trimester 1	*Trimester 2*	*Trimester 3*
11.00 – 11.45	Course AsQT	Course IntPM*	Course AGT
12.00 – 12.45	Course AsQT	Course IntPM*	Course AGT
12.45 – 13.15	Lunch break	Lunch break	Lunch break
13.15 – 14.00	Course AC*	Course NCG	Course RO
14.15 – 15.00	Course AC*	Course NCG	Course RO
15.15 – 16.00	Course IPM	Course ATS	Course SP
16.15 – 17.00	Course IPM	Course ATS	Course SP

* = in cooperation with DIAMANT

Location:
The courses are given in the Uithof (buildings of the Utrecht University), in the Hans Freudenthalbuilding, Room 611AB, Budapestlaan, Utrecht.

Credits:
The credits (including for the attendance of the course) for participants who have passed the exercises successfully are ***4 EC*** per course. In case the courses are only attended (or when the exercises are not passed successfully), then the workload is set at ***1 EC***. At the end of each course the participants receive a *certificate* with the grade and the credits involved.

Registration:
Anyone interested in these courses is invited to fill in the online registration form on the webpage of the LNMB (http://www.lnmb.nl/pages/courses/phdcourses/). For each of the three trimesters a separate form is given. If you are a new PhD student, please also fill in the 'Form for New PhD students' on that webpage.

Course AsQT: "Asymptotic Methods in Queueing Theory"

Time: Monday 11.00 – 12.45 (September 9 – November 11)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturer: Prof.dr. A.P. Zwart (CWI / Eindhoven University of Technology)

Course description:
Exact analysis of complex queueing systems is often out of scope. For many queueing systems it is all but impossible to obtain exact expressions for expected values of performance measures such as queue lengths, waiting times and sojourn time. Also, average values may not even be the most informative measures to describe a system's performace, but one may rather be interested in performance quantiles for example. For such cases a wide range of asymptotic techniques are available that may serve to develop suitable approximations and provide valuable insights. In this course we will discuss several such techniques and illustrate them on more advanced queueing models such as GPS queues, DPS queues, and bandwidth-sharing networks. The following techniques and topics will be discussed:

- Large deviations and tail asymptotics: We discuss several techniques to estimate tail probabilities in queueing systems. We distinguish two intrinsically different scenarios: one in which performance characteristics have light tailed distributions and one with heavy tails. We will explain the fundamental differences between these two scenarios ("conspiracy" versus "disaster" scenarios) and illustrate several analysis techniques that one may resort to in obtaining asymptotically accurate estimates, including analytic asymptotics, probabilistic bounds and coupling arguments.
- Fluid and diffusion limits: For optimization of complex stochastic processes, one may search for simpler versions of the processes that are still accurate enough to design meaningful optimizing control strategies. Fluid and diffusion limits are particularly useful in this context. For the fluid limit, one starts off the stochastic process (for example a queue length process) at an exceptional high level x and monitors it over a long period of time (order x). As the scaling parameter x tends to infinity, the stochastic process can often be shown to satisfy a functional strong law of large numbers, which is commonly referred to as the fluid limit. In applications, the fluid limit may not give sufficient information to design optimal control strategies and one will typically be interested in deviations from the fluid limit. The diffusion limit describes these deviations.
- Perturbation analysis and time-scale separation: analyzing Markovian queueing networks as multi-dimensional Markov processes may be notoriously difficult. One abstraction is to isolate the behavior of a single queue, and capture the influence of other queues in what is called the random environment. The state of the random environment determines the transition laws of the queueing system at hand. As the random environment changes state, the queue can move from one mode of operation to another (for example from lightly loaded conditions to overloaded conditions and back). When the state changes of the random environment occur on a much faster time scale than the queueing dynamics, one obtains a so-called fluid approximation (this is a somewhat different notion than the earlier mentioned fluid limits). On the contrary, if the state changes are extremely slow the limiting process is called a quasi-stationary approximation. This concept of time-scale separation can be formalized using perturbation analysis for Markov processes.
- Heavy traffic: For efficiency, in practice service systems are aimed at being deployed at fairly high loads. As the load on a (queueing) system approaches the critical capacity, typical performance characteristics such as queue lengths and sojourn times grow beyond limits. In the 1960s, Kingman showed that for single-server queues, the queue length process can be scaled such that a meaningful limit is obtained as the critical capacity is approached. In the past half a century, this concept has been extended to much more complex systems and successfully applied in practice, particularly in inventory systems, production facilities, call centers and communication networks. In the course we will discuss the founding principles of heavy traffic theory.

Literature:
Handouts, slides and references to relevant literature will be made available at the lectures.

Prerequisites:
The participants should have followed courses in probability theory, stochastic processes and queueing theory.

Examination:
Take home problems.

Address of the lecturer:
Prof.dr. A.P. Zwart
CWI, Science Park 123 1098 XG Amsterdam
Phone: 020 - 5924018 E-mail: Bert.Zwart@cwi.nl

Course AC: "Algorithms and Complexity"

Time: Monday 13.15 – 15.00 (September 9 – November 11)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturers: Dr. J. Nederlof (Eindhoven University of Technology), Dr. M. Schmidt (Erasmus University Rotterdam)

Course description:
Principles for construction of algorithms: Decomposition, greedy algorithms, dynamic programming. Algorithm analysis. Probabilistic algorithms. Approximation. Selected applications to sets, graphs, and geometry. Exponential time algorithms and Fixed Parameter Tractability.
Complexity Theory: Reductions. Complexity classes P (polynomial time), NP (non-deterministic polynomial time). NP-complete problems.

Literature:
Most material will be provided on the website. Additionally, for parts of the course it may be useful to buy the book `Introduction to Algorithms', by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein.

Prerequisites:
Knowledge of basic mathematics (set and logic notation, linear algebra, proof by induction, probability theory, big-O notation).

Examination:
Homework.

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Dr. M. Schmidt
Rotterdam School of Management, Erasmus University Rotterdam
Burgemeester Oudlaan 50, 3062 PA Rotterdam
Phone: 010 - 4082199 E-mail: schmidt2@rsm.nl URL: https://www.rsm.nl/people/marie-schmidt/

Course IPM: "Interior Point Methods"

Time: Monday 15.15 – 17.00 (September 9 – November 11)
Location: Hans Freudenthalgebouw,, Room 611AB, Budapestlaan, Utrecht
Lecturer: Prof.dr. E. de Klerk (Tilburg University)

Course description:
The field of optimization, particularly linear, convex and semi-definite optimization, has been given a new impulse by the development of interior point methods. Besides the existence of a new theory, there is a tremendous activity in new applications, especially in semi-definite programming.

The topics for this course include:
– interior-point methods for conic programming;
– classical duality theory for conic programming;
– symmetric cones;
– primal-dual interior-point algorithms;
– semidefinite programming.

Literature:
– main course notes (students: please buy or borrow this book before the course starts. If you order the book from Amazon.com, then allow enough time for delivery);
– James Renegar, "A Mathematical View of Interior-Point Methods for Convex Optimization". MPS-SIAM Series on Optimization, Philadelphia (2001);
– additional course notes:
Stephen Boyd and Lieven Vandenberghe. Convex Optimization, Cambridge University Press (2004).
Available online: http://www.stanford.edu/~boyd/cvxbook/.

Prerequisites:
Basic knowledge (bachelor level) of analysis (multivariate calculus) and linear algebra, as well as a first course in linear and nonlinear programming.

Examination:
Take home problems.

Address of the lecturer:
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Course IntPM: "Integer Programming Methods"

Time: Monday 11.00 – 12.45 (November 18 – December 16 and January 20 – February 17)
Location: Hans Freudenthalgebouw, Room 611AB, Leuvenlaan, Utrecht
Lecturers: Dr. R. Spliet (Erasmus University Rotterdam), Dr. M. Walter (University of Twente)

Course description:
The vast majority of problems in combinatorial optimization can be formulated as an integer linear program (ILP): Maximize or minimize a linear objective function subject to linear constraints and the additional restriction that the decision variables can take only integer values (typically only 0/1). This makes ILP's a perfect tool for formulating problems in combinatorial optimization; many software packages are available for this. The drawback is that solving ILP's is generally a computationally demanding task; it is NP-hard. Nevertheless, in practice, also these problems have to be solved. In this part of the course we focus on techniques for solving ILP's.

The following topics will be treated:
- the expressive power of ILPs in combinatorial optimization;
- geometry of integer linear programs;
- easy and difficult ILPs;
- geometric techniques based on cutting planes;
- decomposition techniques.

Literature:
Conforti, Cornuéjols, and Zambelli, Integer programming, Springer 2014 (available online via springerlink).

Prerequisites:
Knowledge of linear algebra and linear programming.

Examination:
Take home problems.

Address of the lecturers:
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Dr. Matthias Walter
University of Twente, Faculty of Electrical Engineering, Mathematics & Computer Science
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Phone: 053 - 4898744 E-mail: m.walter@utwente.nl

Course NCG: "Noncooperative Games"

Time: Monday 13.15 – 15.00 (November 18 – December 16 and January 20 – February 17)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturers: Dr. M. Staudigl (Maastricht University), Prof.dr. F. Thuijsman (Maastricht University)

Course description:
This course consists of 2 parts both of which focus on noncooperative games in the following order: matrix and bimatrix games, repeated games, specific models of stochastic (Markov) games, evolutionary games and generalized games. We explore solution concepts like "value" and "optimal strategies" for zero sum games and "equilibrium" for non-zero sum games as well as methods to calculate these. In these noncooperative games the players are strategic decision makers, who cannot make binding agreements to achieve their goals. Instead, threats may be applied to establish stable outcomes. This course will also emphasize connections between certain "smooth games" with Monotone Inclusions and Variational Inequalities. This approach allows us to describe the fundamental role game theory plays in modern online convex optimization and machine learning.

Topics to be covered:
- Solving two-player games using mathematical programming;
- Equilibrium analysis for repeated games;
- Behavioral equilibria for limiting average, infinite horizon, stochastic (Markov) games.

- Nash equilibrium and Variational Inequalities (VI):
    - Convex and Monotone Functions;
    - Variational Inequalities and Nash equilibria.
- Saddle Point Problems and their role in Machine learning:
    - Online Convex Optimization (OCO);
    - No-Regret Dynamics;
    - Minimax Duality via no-regret.
- Generalized Nash equilibrium:
    - Definition and formulation as Monotone Inclusion;
    - Splitting Methods;
    - Mathematical Programming Formulations.

Literature:
For background literature on Online Convex Optimization we will use the free textbook 'Introduction to Online Convex optimization', by Elad Hazan: http://ocobook.cs.princeton.edu/OCObook.pdf

Since there is no real textbook covering these topics, lecture notes will be distributed for this course.

Prerequisites:
Basic knowledge (bachelor level) of analysis (multivariate calculus) and linear algebra, as well as a first course in linear and nonlinear programming. Basic knowledge of Functional Analysis and Topology is also recommended, but not necessary.

Examination:
Take home exams. These assignments have to be completed in groups of at most two students.

Address of the lecturers:
Dr. M. Staudigl
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P.O. Box 616, 6200 MD Maastricht
Phone : 043 - 3884630 E-mail : m.staudigl@maastrichtuniversity.nl

Prof.dr. F. Thuijsman
Department of Knowledge Engineering, Maastricht University
P.O. Box 616, 6200 MD Maastricht
Phone: 043 - 3883489 E-mail: f.thuijsman@maastrichtuniversity.nl

Course ATS: "Advanced Topics in Stochastic Operations Research"

Time: Monday 15.15 – 17.00 (November 18 – December 16 and January 20 – February 17)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturer : Dr. A.V. den Boer (Universiteit van Amsterdam)

Course description:
In this course we will study data-driven decision problems: optimization problems for which the relation between decision and outcome is unknown upfront, and thus has to be learned on-the-fly from accumulating data. This type of problems has an intrinsic tension between statistical goals and optimization goals: learning how the system behaves (the statistical goal) is accelerated by experimenting with different actions, while for taking good decisions (the optimization goal), one would like to limit experimentation and instead use estimated optimal decisions. We will study this `exploration-exploitation' trade-off for so-called `multi-armed bandit problems', the paradigmatic framework for dynamic optimization problems with incomplete information. We will discuss standard building blocks of the theory, and focus on applications in operations research such as dynamic pricing and assortment optimization problems.

Literature:
Will be provided during the course, a.o. Bandit Algorithms by Tor Lattimore and Csaba Szepesvári (online available).

Prerequisites:
Probability theory and statistics, and some coding skills (Python/Matlab).

Examination:
Take home problems.

Address of the lecturer:
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Universiteit van Amsterdam
Postbus 94248, 1090 GE Amsterdam
Phone: 020 - 5252497 E-mail: A.V.denBoer@uva.nl

Course AGT: "Algorithmic Game Theory"

Time: Monday 11.00 – 12.45 (February 24 – April 6, April 20, May 4 – May 11)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturer : Prof.dr. G. Schäfer (VU University Amsterdam / CWI)

Course description:
Algorithmic game theory is a rather new and rapidly growing research area that lies at the intersection of mathematics, theoretical computer science and economics. It uses game-theoretical models and solution concepts to study situations of strategic decision making, with a particular focus on computational and algorithmic issues.
It combines methodologies and techniques from areas like discrete optimization, algorithms, computational complexity, game theory, mechanism design, etc.
The overall goal of the course is to both learn about fundamental results of the field and to get acquainted with recent state-of-the-art techniques.

Potential topics that will be covered in the course are:
– computation of equilibria (potential function, PPAD-completeness);
– inefficiency of equilibria (price of stability, price of anarchy);
– selfish routing games (non-atomic, atomic, price of anarchy);
– congestion games (potential games, PLS-completeness);
– smoothness of games (robust price of anarchy, learning);
– reducing the inefficiency (network tolls, Stackelberg routing);
– combinatorial auctions (first-price, second-price, VCG mechanism);
– approximation and mechanism design (single-minded bidders);
– ad auctions and the generalized second-price auction;
– revenue maximization and the Bayesian setting.

Literature:
– lecture notes will be provided in class;
– most topics that will be covered in the course can be found in the following book:
N. Nisan, T. Roughgarden, E. Tardos, and V.V. Vazirani (Editors), Algorithmic Game Theory, Cambridge University Press, 2007.
Note: The full-text of the book is available online here (username=agt1user, password=camb2agt).

Prerequisites:
– basic knowledge of algorithms, optimization and computational complexity;
– some knowledge of game theory is advantageous.

Examination:
Take home problems.

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Course RO: "Robust Optimization"

Time: Monday 13.15 – 15.00 (February 24 – April 6, April 20, May 4 – May 11)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturers: Prof.dr.ir. D. den Hertog (Tilburg University), Dr. Frans de Ruiter (CQM)

Course description:
Optimization problems often contain parameters that are uncertain. The recent methods developed in Robust Optimization try to find solutions that are robust against these uncertainties. The idea is to define a so-called

uncertainty region for the uncertain parameters, and then require that the constraints should hold for all parameter values in this uncertainty region. For several optimization problems, and for several choices of the uncertainty region, it has been shown that this so-called robust counterpart problem can be reformulated as tractable optimization problems.

The main topics treated are:

- Uncertain *lineair* optimization (LO) problems:
  - data uncertainty in LO;
  - tractability of robust counterparts;
  - non-affine perturbations;
  - applications in logistics, marketing, finance, engineering, … .
- Uncertain *nonlineair* optimization problems:
  - tractability of robust counterparts;
  - examples.
- Robust adjustable multistage optimization:
  - adjustable robust counterpart;
  - affine decision rules;
  - non-affine decision rules.
- Robust counterpart approximations of scalar chance constraints:
  - how to specify an uncertainty set?;
  - chance constraints;
  - safe tractable approximations.
- Globalized robust counterparts of uncertain problems:
  - motivation and definition of globalized robust counterpart;
  - computational tractability.

Literature:
– handouts;
– Lecture notes on Robust Optimization, by Dimitris Bertsimas and Dick den Hertog.

Prerequisites:
– knowledge of basic linear algebra;
– knowledge of linear programming and duality;
– basic knowledge of convex analysis and non-linear optimization.

Examination:
Take home problems.

Address of the lecturers:
Prof.dr.ir. D. Den Hertog
Tilburg School of Economics and Management , Tilburg University
P.O. Box 90153, 5000 LE Tilburg
Phone: 013 - 4662122 E-mail: d.denhertog@uvt.nl

Dr. Frans de Ruiter
CQM, Postbus 414, 5600 AK Eindhoven
E-mail: deruiter@cqm.nl

Course SP: "Stochastic Programming"

Time: Monday 15.15 – 17.00 (February 24 – April 6, April 20, May 4 – May 11)
Location: Hans Freudenthalgebouw, Room 611AB, Budapestlaan, Utrecht
Lecturers: Dr. W. Romeijnders (University of Groningen)

Course description:
Stochastic programming (see also http://stoprog.org) is a framework for modelling optimization problems that involve uncertainty. Whereas deterministic optimization problems are formulated with known parameters, real world problems almost invariably include some unknown parameters. When the parameters are known only within certain bounds, one approach to tackling such problems is called robust optimization. Here the goal is to find a solution which is feasible for all such data and optimal in some sense. Stochastic programming models are similar in style but take advantage of the fact that probability distributions governing the data are known or can be estimated. The goal here is to find some policy that is feasible for all (or almost all) the possible data instances and maximizes the expectation of some function of the decisions and the random variables. More

generally, such models are formulated, solved analytically or numerically, and analyzed in order to provide useful information to a decision-maker.

The most widely applied and studied stochastic programming models are two-stage linear programs. Here the decision maker takes some action in the first stage, after which a random event occurs affecting the outcome of the first-stage decision. A recourse decision can then be made in the second stage that compensates for any bad effects that might have been experienced as a result of the first-stage decision. The optimal policy from such a model is a single first-stage policy and a collection of recourse decisions (a decision rule) defining which second-stage action should be taken in response to each random outcome.

The following subjects are discussed:
– concepts and examples of stochastic programming;
– stochastic linear programming;
– recourse models;
– chance constraints;
– SP calculus (e.g. convexity; approximation of distributions);
– algorithms;
– stochastic integer programming;
– multi-stadia recourse models;
– case study.

Literature:
Lecture notes will be provided.
Indication for the level:
– J.R. Birge and F. Louveaux, Introduction to stochastic programming, Springer, 1997;
– P. Kall and S.W. Wallace, Stochastic programming, Wiley-Interscience Series in System and Optimization, 1994.

Prerequisites:
– basic knowledge of probability theory: S.M. Ross, Introduction to probability models, 8th edition, Academic Press, 2003 (chapters 1-3);
– basic knowledge of linear programming: V. Chvatal, Linear programming, Freeman, 1983.

Examination:
Take home problems, case study.

Address of the lecturer:
Dr. W. Romeijnders
Department of Operations, University of Groningen
P.O. Box 800, 9700 AV Groningen
Phone: 050 - 3638613 E-mail: w.romeijnders@rug.nl

5. Master courses 2019/2020

During the academic year 2019/2020 five courses will be taught in two semesters; each semester has a duration of 14 weeks. The courses are part of the Dutch Master Programme in Mathematics (https://elo.mastermath.nl/).

Fall 2019:
– CO (Continuous optimization);
– DO (Discrete optimization).

Spring 2020:
– ALP (Advanced linear programming);
– SCH (Scheduling);
– QT (Queueing theory).

The courses are given on Monday according to the following schedule:

	Fall 2019	*Spring 2020*
11.00 – 11.45	Course CO	Course SCH
12.00 – 12.45	Course CO	Course SCH
12.45 – 13.15	Lunch break	Lunch break
13.15 – 14.00	Course DO	Course ALP*
14.15 – 15.00	Course DO	Course ALP*
15.15 – 16.00		Course QT
16.15 – 17.00		Course QT

* In cooperation with DIAMANT

Location:
The courses are given in the Uithof (buildings of the Utrecht University). Detailed information on the location can be found on the website of the Dutch Master Programme in Mathematics (Masthermath): https://elo.mastermath.nl/.

Credits:
The credits for students who have passed the exercises successfully are 6 EC per course.

Detailed information about the courses:
The registration and administration of the master courses is done by the Dutch Master Programme in Mathematics. Anyone interested in these courses is invited to register via https://elo.mastermath.nl/ . On this website you can also find more information on the content of the courses, the location and any further relevant information.

Course CO: "Continuous Optimization"

Time : Monday 11.00 – 12.45
Location: Utrecht (De Uithof)
Lecturer : Dr. D.N. Dadush (CWI)

Address of the lecturer:
Dr. D.N. Dadush
CWI, Science Park 123, 1098 XG Amsterdam
Phone: 020 - 5924210 E-mail: D.N.Dadush@cwi.nl

Course DO: "Discrete Optimization"

Time : Monday 13.15 – 15.00
Location: Utrecht (Uithof)
Lecturer : Prof.dr. M. Uetz (UT)

Addresses of the lecturers:
Prof.dr. M. Uetz
Dept. of Applied Mathematics, Faculty EEMCS, University of Twente
P.O. Box 217, 7500 AE Enschede
Phone: 053 - 4893402 E-mail: m.uetz@utwente.nl

Course SCH: "Scheduling"

Time : Monday 11.00 – 12.45
Location: Utrecht (De Uithof)
Lecturers: Prof.dr. J.L. Hurink (UT), Dr.ir. J.T. van Essen (TUD)

Addresses of the lecturers:
Prof.dr. J.L. Hurink
Dept. of Applied Mathematics, Faculty EEMCS, University of Twente
P.O. Box 217, 7500 AE Enschede
Phone: 053 - 4893447 E-mail: j.l.hurink@utwente.nl

Dr. ir. J.T. van Essen
Delft Institute of Applied Mathematics, Delft University of Technology
Van Mourik Broekmanweg 6, 2628 XE Delft
Phone: 015 - 2785764 E-mail: j.t.vanessen@tudelft.nl

Course ALP: "Advanced Linear Programming"

Time : Monday 13.15 – 15.00
Location: Utrecht (De Uithof)
Lecturers: Prof.dr. L. Stougie (VU)

Addresses of the lecturer:
Prof.dr. L. Stougie
Dept. of Econometrics and Operations Research, VU University Amsterdam
De Boelelaan 1105, 1081 HV Amsterdam
Phone: 020 - 5989391 E-mail: l.stougie@vu.nl

Course QT: "Queueing Theory"

Time : Monday 15.15 – 17.00
Location: Utrecht (De Uithof)
Lecturers: Prof.dr. R. Núñez-Queija (UvA), Dr. J.A.C. Resing (TU/e)

Addresses of the lecturers:
Prof.dr. R. Núñez-Queija
Korteweg de Vries Instituut for Mathematics, University of Amsterdam, P.O. Box 94248, 1090 GE Amsterdam
Phone: 020 - 5252 5010; E-mail: nunezqueija@uva.nl

Dr. J.A.C. Resing
Department of Mathematics and Computer Science, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven
Phone: 040 - 2472984 E-mail: j.a.c.resing@tue.nl

6. Structuurschets interne organisatie LNMB (in Dutch)

Vastgesteld in de algemene ledenvergadering van 16 januari 1991, aangepast in de algemene ledenvergaderingen van 16 januari 2007, 18 januari 2011, 17 januari 2012 en 13 januari 2015.

0. Preambule
De juridische structuur van het LNMB is nog niet vastgelegd, en dat gebeurt ook niet door onderstaande structuurschets. Op dit moment is het niet opportuun om de juridische aspecten volledig uit te werken, dat zal te zijner tijd gebeuren in samenhang met de uitwerking van de structurele financiering. Bovendien is het wenselijk om te wachten tot de discussie over "onderzoekscholen" verder gevorderd is. Wel is het op dit moment noodzakelijk om interne gedragsregels af te spreken, onder meer omdat de hoogleraar-directeur is aangesteld.

1. Het Landelijk Netwerk Mathematische Besliskunde
Het LNMB is een organisatie die een landelijke tweedefase-onderzoekersopleiding in de mathematische besliskunde verzorgt. Door landelijke bundeling van internationaal erkende expertise en door inzet van vooraanstaande onderzoekers uit het buitenland wordt gestreefd naar een opleiding van hoge kwaliteit. Het LNMB streeft naar een goede afstemming van activiteiten met de universitaire instellingen en met andere tweedefaseopleidingen.

2. Leden
Lid van het LNMB kunnen zijn hoogleraren, UHD's en UD's (inclusief emeriti) van de Nederlandse universiteiten of medewerkers van het CWI die actief onderzoeker zijn op een van de deelgebieden van de mathematische besliskunde en betrokken zijn bij de begeleiding van promovendi. Over toelating van nieuwe leden beslist het algemeen bestuur.

3. Algemeen bestuur
Het algemeen bestuur bestaat uit ten minste n en ten hoogste $n+m$ leden van het LNMB, waar n = het aantal instellingen waar leden werkzaam zijn en m = het aantal leden van het dagelijks bestuur. Het algemeen bestuur wordt gekozen door de ledenvergadering zodanig dat van elk van de n instellingen ten minste één personeelslid lid van het algemeen bestuur is. Leden van het dagelijks bestuur zijn automatisch lid van het algemeen bestuur. De voorzitter wordt in functie gekozen. De directeur is secretaris. Het algemeen bestuur verdeelt onderling de overige functies. Leden van het algemeen bestuur die geen lid zijn van het dagelijks bestuur treden jaarlijks af, en zijn terstond herkiesbaar. Voor de overige leden van het algemeen bestuur geldt het rooster van bestuursmutaties van het dagelijks bestuur.
Het algemeen bestuur heeft tot taak:
a. het benoemen van nieuwe leden van het LNMB;
b. het benoemen van de directeur;
c. het toezien op de activiteiten van het dagelijks bestuur;
d. het jaarlijks vaststellen van het algemeen en financieel verslag, alsmede van de begroting voor het komende jaar;
e. alles te doen wat de doelstellingen van het LNMB kan bevorderen.

4. Dagelijks bestuur
Het dagelijks bestuur bestaat uit vijf of zes leden van het LNMB. Het dagelijks bestuur wordt gekozen door de ledenvergadering. Voorzitter en secretaris van het algemeen bestuur zijn tevens voorzitter en secretaris van het dagelijks bestuur. De leden van het dagelijks bestuur, m.u.v. de directeur, hebben een zittingstermijn van vier jaar. Aftredende leden zijn éénmaal herkiesbaar. De zittingstermijn van de secretaris komt overeen met diens aanstelling als directeur.
De voorzitter wordt in functie gekozen en heeft een zittingstermijn van vier jaar als voorzitter.
Het dagelijks bestuur heeft tot taak:
a. het vaststellen van het onderwijsprogramma van het LNMB, in het bijzonder de aanwijzing van de docenten;
b. het vaststellen van regels voor de beoordeling van de deelnemende aio's/oio's door de docenten en het vaststellen van slaagregels;
c. het vaststellen van cursusgelden, contributies, vergoedingen etc.;
d. het vaststellen van regelingen voor diploma's, en het afgeven van diploma's aan deelnemers die geslaagd zijn;
e. het jaarlijks uitbrengen van een begroting, ten behoeve van het algemeen bestuur;
f. het zorgdragen voor de continuïteit van de activiteiten van het LNMB; inhaken op actuele ontwikkelingen, het veilig stellen van structurele financiering etc.;
g. het adviseren van de directeur bij diens taakuitoefening;
h. alles te doen wat de doelstellingen van het LNMB kan bevorderen.

Het dagelijks bestuur is verantwoording verschuldigd aan het algemeen bestuur en aan de ledenvergadering.

5. Directeur
Het LNMB heeft een directeur. De functie van directeur wordt op hoogleraarniveau vervuld. De directeur wordt benoemd door het algemeen bestuur, in samenwerking met de penvoerende instelling. De termijn van de aanstelling wordt eveneens in overleg met de penvoerende instelling vastgelegd.
De directeur heeft tot taak:

a. het voorbereiden en doen uitvoeren van het onderwijsprogramma;
b. het beslissen omtrent toelating van deelnemers aan het onderwijsprogramma op grond van door het dagelijks bestuur vastgestelde regels;
c. het bijhouden van een administratie van deelnemers aan het onderwijsprogramma, en de door hen behaalde resultaten;
d. het toezicht houden op het financieel beheer dat namens het LNMB wordt gevoerd;
e. het voorbereiden van de vergaderingen van het dagelijks bestuur, het algemeen bestuur en de ledenvergadering;
f. het opstellen van voorlichtingsmateriaal voor aio's/oio's en andere belangstellenden;
g. het verzorgen van goede contacten met de penvoerende instelling, met deelnemende aio's/oio's en hun promotoren, met docenten, met instellingen die bij het LNMB zijn betrokken en met verwante netwerken.

De directeur is verantwoording verschuldigd aan het dagelijks bestuur.

6. Ledenvergadering
Ieder kalenderjaar, bij voorkeur tijdens de jaarlijkse Lunteren-conferentie, wordt een ledenvergadering gehouden, waar onder meer aan de orde komen:

a. het algemeen verslag over het afgelopen kalenderjaar;
b. de plannen voor het komende kalenderjaar.

De ledenvergadering heeft verder tot taak:

c. de benoeming van de leden van het dagelijks bestuur en van het algemeen bestuur;
d. het vaststellen van de gedragregels die binnen het LNMB worden gehanteerd.

7. Financiën
Voor de periode 1989 – 1993 heeft de Minister van Onderwijs en Wetenschappen het LNMB een startsubsidie toegekend. Daarna hebben de instellingen via een jaarlijkse bijdrage gezorgd voor het voortbestaan van het LNMB. De gelden wordt beheerd door de penvoerende instelling. Betalingen behoeven de goedkeuring van de directeur, die gehouden is aan regels die door het Dagelijks bestuur zijn vastgelegd.

8. Slot
In alle gevallen waarin deze regels niet voorzien, beslist het dagelijks bestuur.

7. Operations Research Groups at Dutch Universities and CWI

In almost all Dutch universities and at the CWI research groups in the area of Operations Research can be found. Their main research themes and the projectleaders of the groups are given below. More detailed information on the considered topics, the research staff and contact information can be found on http://www.lnmb.nl/pages/dutchorgroups/.

Nr.	Institution	Research Theme	Projectleader(s)
1a.	CWI	Networks & Optimization	Schäfer
1b.	CWI	Stochastics	Zwart/Van der Mei
2.	EUR	Operations Research	Dekker
3.	WUR	Operations Research	Haijema
4a.	TiU	Operations Research	Sotirov
4b.	TiU	Game Theory	Borm
5a.	UM	Combinatorial optimization	Van Hoesel
5b.	UM	Game theory and optimization	Thuijsman
6.	RUG	Operations Research	Teunter
7.	UL	Stochastic Operations Research	Spieksma
8	TUD	Optimization	Aardal
9.a	TU/e	Combinatorial optimization	Spieksma
9.b	TU/e	Stochastic Operations Research	Boxma
10.	UvA	Applied probability and Discrete mathematics	Mandjes/Schrijver
11.	UT	Discrete Optimization and Stochastic OR	Boucherie/Uetz
12.	UU	Algorithms and Optimization	van den Akker/Bodlaender
13a.	VU	Combinatorial Optimization and Stochastic OR	Stougie
13b.	VU	Optimization of business processes	Koole

8. LNMB certificated persons (344)

J.J. Aarts	Abhishek	M.A. Abidini
F. Ahmed	J.M. van den Akker	M.E. Angün
A. Asadi	A. Aveklouris	R.M. Badenbroek
E.S. Badila	N. Baër	X. Bai
T.C. van Barneveld	E.M. Bázsa	R. Bekker
P.L-J. van den Berg	J. Berkhout	G. Bet
S. Bhulai	J.J.P.H. Bierbooms	M. Bijvank
I.A. Bikker	H.M. le Blanc	J.M. Bloemhof – Ruwaard
C.A. Boer	K.M.J. de Bontridder	M. van der Boor
N.K. Boots	N.J. Borgman	S.C. Borst
T.N. Bosman	H.C.M. Bossers	R.J. Boucherie
Y. Boulaksil	H.W. Bouma	P.C. Bouman
A. Braaksma	G.M. te Brake	R.C.M. Brekelmans
T. Breugem	M. van Brink	M.P. de Brito Peirera Maduro
A.J. uit het Broek	J.J.J. van de Broek	J. Bruin
S.P.J. van Brummelen	G. Budai	A. Buijsrogge
A. Bump	N.C. Büyükkaramikli	E.J. Cahen
M. Calinescu	S. Caner	F. Cecchi
D. Chaerani	S.K. Cheung	T.J.M. Coenen
H. Cetinay	M.B. Combé	U. Corbacioglu
K. Cornelissen	M. Cremers	F.C.A.M. Cruijssen
G. Csapó	S. Dabia	K. Dalmeijer
Q. Deng	A.B. Dieker	B.J. Dietzenbacher
A.S. Dijkstra	E.B. Diks	S. Ding
A.M. Dobber	C. Dobre	M.K. Dogru
T. Dollevoet	J.P. Dorsman	A.B. Dragut
J. Driessen	L.E. Duijzer	M. van Ee
R. Egorova	C.A. van Eijl	S.C.M. ten Eikelder
E. Elabwabi	M. Elghami	I. Endrayanto
J. Ensinck	J.T. van Essen	A. Estevez Fernandez
L. Evers	Y. Feng	M. Firat
S.T.G. Fleuren	M. Frolkova	J. van der Gaast
O. Gabali	J. Ge	Q. Ge
R. van de Geer	S.M. Geervliet	J.R.G. van Gellekom
K. Glorie	J.-W. Goossens	B. Gorissen
F.N. Gouweleeuw	R.M.P. Goverde	A. Grigoriev
E.A. Grigorieva	G. Gu	R. de Haan
A. Haesel	R. Haijema	J.M.A. Heemskerk
W.J.A. van Heeswijk	C.J.H. Hendriksen	D. den Hertog
W. van den Heuvel	I. van Heuven van Staereling	B. Heydenreich
F.J. von Heymann	A. Hristov	R.P. Hoeksma
K.M.R. Hoen	R. Hoogervorst	W.L.F. van der Hoorn
W.B. van den Hout	G.-J.J.J.A.N. van Houtum	S. Huijink
D. Huisman	P.J.H. Hulshof	E. van der Hurk
B.G.M. Husslage	L.J.J. van Iersel	V.C. Ivanescu
I.D. Ivanov	W. van Jaarsveld	C.J. Jagtenberg
B. Jansen	J.B. Jansen	M. Jansen
E. Janssen	F.B.S.L.P. Janssen	T.M.L. Janssen

J. de Jong
B. de Jonge
B. Kamphorst
R.P. Kampstra
A.G. Karaarslan
V. Karels
F.J.P. Karsten
B. Kaynar
B. de Keijzer
M.A. de Kemp
R.B.O. Kerkkamp
O.A. Kilic
B.-E. Klaus
T. van der Klauw
J.G. Klein
M.J. Kleijn
J. Kleppe
E. de Klerk
F. Klijn
S. Klootwijk
A.L. Kok
G.M. Koole
J. de Kort
N. Kortbeek
P. Korteweg
A.M.C.A. Koster
M. Koster
P. Kovács
S. Kovaleva
A.F. van der Kraaij
M.G.C. van Krieken
J.T. de Kruijff
D. Krushinsky
B.H.M. Kuijpers
C.M.H. Kuijpers
C.M. Laan
R. Langestraat
T. Le Anh
T. Le Duc
A.G. Leeftink
R.L.M.J. van Leensel
D. van Leeuwen
S. Li
H.L. Liem
P. Lieshout
O. Listes
B.M. Litjens
J.A. Loeve
E.R.M.A. Lohmann
R.B. Lok
J.M.W. van Loon
F.J.W. Lutgens
M. Mainegra Hing
M.R.H. Mandjes
H. Mansouri
S. Marban
B. Marchal
N.A.A. Marquinie
B.W.J. Mathijsen
Mayank
P.J.M. Meersmans
M.A. Meertens
F.J.C. van Megen
R.D. van der Mei
W.J.M. Meuffels
T.M.M. Meyfroyt
G. Mincsovics
D.I. Miretskiy
M. Mitici
M. Mnich
J. Mulder
R. Nicolai
L. van Norden
R. Núñez Queija
A. Oblakova
M.C.A. Olde Keizer
N.J. Olieman
M. Oosten
C.D. van Oosterom
D. van Ooteghem
G.J.M. Otten
P. Out
P. Ouwehand
Ö. Özdemir
U. Özen
K. Pak
O. Passchier
J.J. Paulus
L.W.P. Peeters
N. Piersma
S.C. Polak
G.J. Polinder
P.C. Pop
E. Porras Musalem
S.A. Pot
D. Potthoff
M. Pourakbar
D.R.J. Prak
X. Qiu
M. Quant
A.J. Quist
G. Regts
J.H. Reijnierse
G. Rennen
M. Retel Helrich
J.S. Rhuggenaath
W. Romeijnders
D. Romero Morales
J.M.M. van Rooij
E.J. Roos
A. Roubos
D. Roubos
C.A.M. de Ruijt
J. Rutten
J.H.G.C. Rutten
J.H.J. van Sambeeck
J. Sanders
L.P.J. Schlicher
M.H.H. Schoot Uiterkamp
A.H. Schrotenboer
B. Selçuk
J. Selen
B. Serbetci
D. Sever
A.Y.D. Siem
B.P. Silalabi
A. Sleptchenko
M. Slikker
E. Smeitink
J. Smeltink
M.A.J. Smith
S.R. Smits
M. Sol
M.J. Soomer
P.F. Spaans
F.C.R. Spieksma
R. Spliet
J.M. Spitter
N.J. Starreveld
M.H. Streutker
S. van der Ster
P.J. Storm
J.F. Sturm †
Z. Sun

D. Tas	M. Tennekes	R.H. Teunter
V. Timmermans	D.D. Tönissen	M. Udenio
M.J.G. van Uitert	A. Ule	R. van Urk
N. Usotskaya	R.J.M. Vaessens	P.T. Vanberkel
K. Vandyshev	S.G. Vanneste	E. Vatamidou
E.J.M. van der Veen	M. Veenstra	H.J.J. Verheijen
C. Verhoef	M. Verloop	A.J. Vermeulen
A.M. Verweij	A.P.A. Vestjens	M. Vieira
I.F.A. Vis	P. Vis	T.R. Visser
M. Vlasiou	M.H. van der Vlerk	I. Vliegen
A. van Vliet	J.P.A. van Vliet	Y. Volkovich
T. Vredeveld	H. de Vries	M.J.C.M. Vromans
N.M. van de Vrugt	M. van Vuuren	X. Wang
M. Wennink	W. van der Weij	A.C.C. van Wijk
R. Wildeman	E.M.M. Winands	R. Yang
Z. Yang	Q.C. Ye	T. Yuan
J. Zhen	Q. Zhu	Q.C. Zhu
A. Zocca	M.E. Zonderland	C.M. Zwaneveld
A.P. Zwart	B.G. Zweers	

9. List of Members, PhD students and Alumni

List of the members, PhD students and alumni of the LNMB are available on
http://www.lnmb.nl/pages/people