DUTCH NETWORK ON THE MATHEMATICS OF OPERATIONS RESEARCH (LNMB)

MASTER AND PhD PROGRAMME IN OPERATIONS RESEARCH

Information Guide 2011/2012

June 2011
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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 25 courses for Master and PhD students. This year seven 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 2011/2012 consists of the following courses.

Master courses:
Fall 2011:
- Introduction to Stochastic Processes;
- Continuous Optimization;
- Discrete Optimization;
Spring 2012:
- Advanced linear programming;
- Scheduling;
- Queueing theory.

PhD courses:
Trimester 1:
- Stochastic Models for Telecommunication Systems;
- Randomized Algorithms.
- Combinatorial Optimization 2a;
Trimester 2:
- Combinatorial Optimization 2b;
- Noncooperative games;
- Markov Decision Processes.
Trimester 3:
- Operations Research and Health Care;
- Advanced Queueing Theory;
- OR Games.

Besides information about the LNMB courses, this guide contains:
- Organizational and administrative affairs;
- Information about the operations research groups at the Dutch universities;
- 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 37th Lunteren Conference on the Mathematics of Operations Research. This conference will be held 17 - 19th January 2012.

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

Johann Hurink,
Scientific director LNMB
June, 2011
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 113 members and 165 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 consists of a biennial cycle and in each cycle 18 courses are offered. 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 or 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/](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 also can 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. 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 will receive a diploma. Here, 'sufficiently' means total credits of 25 EC. 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. After consultation with the director, it is possible that credit points from a related PhD network also count as credit points for the LNMB diploma.
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, a national concentration is efficient and can help to guarantee a qualitatively high education. This is the main purpose of the LNMB Master courses. An additional advantage for the students is the 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) three or four 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 or 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 well as PhD-students have to register for the Master courses of the LNMB via the website of Mastermath (http://www.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 2011/2012

During the academic year 2011/2012 nine courses will be taught in three trimesters; each trimester has a duration of nine weeks.

Trimester 1 (September 12 – November 7):
- SMTS (Stochastic Models for Telecommunication Systems)
- RA (Randomized Algorithms)
- CO2a (Combinatorial Optimization 2a)*

Trimester 2 (November 14 – December 12 & January 23 – February 13):
- CO2b (Combinatorial Optimization 2b)*
- NCG (Noncooperative games)
- MDP (Markov Decision Processes)

Trimester 3 (February 20 – April 2, April 16 and 23):
- ORHC (Operations Research and Health Care)
- AQT (Advanced Queueing Theory)
- ORG (OR-Games)

* The courses Combinatorial Optimization 2a and 2b can be followed without knowledge of the courses Combinatorial Optimization 1a and 1b.

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Trimester 1</th>
<th>Trimester 2</th>
<th>Trimester 3</th>
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<tbody>
<tr>
<td>10.15-11.00</td>
<td>Course SMTS</td>
<td>Course CO2b*</td>
<td>Course ORHC</td>
</tr>
<tr>
<td>11.15-12.00</td>
<td>Course SMTS</td>
<td>Course CO2b*</td>
<td>Course ORHC</td>
</tr>
<tr>
<td>12.00-13.00</td>
<td>Lunch break</td>
<td>Lunch break</td>
<td>Lunch break</td>
</tr>
<tr>
<td>13.00-13.45</td>
<td>Course RA*</td>
<td>Course NCG</td>
<td>Course AQT</td>
</tr>
<tr>
<td>14.00-14.45</td>
<td>Course RA*</td>
<td>Course NCG</td>
<td>Course AQT</td>
</tr>
<tr>
<td>15.00-15.45</td>
<td>Course CO2a*</td>
<td>Course MDP</td>
<td>Course ORG</td>
</tr>
<tr>
<td>16.00-16.45</td>
<td>Course CO2a*</td>
<td>Course MDP</td>
<td>Course ORG</td>
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</table>

* = in cooperation with DIAMANT

**Location**
The courses are given in the Uithof (buildings of the Utrecht University), in the Mathematical Building, 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 SMTS: “Stochastic Models for Telecommunication Systems”

*Time*: Monday 10.15 – 12.00 (September 12 – November 7).
*Location*: Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
*Lecturers*: Prof.dr. R.D. van der Mei (CWI & VU) and Prof.dr. M.R.H. Mandjes (UvA)

**Course description:**
The course consists of two synergistic parts.
Part I: stochastic models for telecommunication systems at the packet/burst level
Part II: stochastic models for telecommunication systems at the call/flow level.

**Part I:**
At the packet/burst level performance aspects of telecommunication networks can be modeled well by using fluid systems - think of packet delays and loss in the buffers of an IP (Internet protocol) based network. Part I of the course treats these fluid models, focusing on single-node queues. The most
prominent subjects are: (1) the M/D/1 queue; (2) the /D/1 queue fed by periodic sources; (3) the Anick-Mitra-Sondhi model; (4) general Markov-fluid driven queues; (5) exponential decay of the overflow probability; (6) effective bandwidth; (7) reduction of fluid models to the call level, to enable the application of the results of Part II.

Part II:
Call/flow-level models are used for dimensioning and planning of communication networks. Performance measures of interest are e.g. call blocking probabilities, flow throughputs and file transfer- or document download times.

In part II the following subjects are treated:
(1) traffic modelling at the call level, and traffic measurements in operational networks;
(2) performance models for streaming traffic (speech, video), such as the Erlang and Engset models, multi-rate models, call admission policies like trunk reservation, loss networks, etc.;
(3) performance models for elastic traffic (data), such as the processor-sharing queueing model;
(4) flow level models for performance evaluation and optimization of Wireless LANs, UMTS/HSDPA and wireless ad-hoc networks;
(5) "Quality-of-Service aware" dimensioning of data networks.

Literature:
Lecture notes will be provided.

Prerequisites

Examination:
Take home problems.

Address of the lecturers:
Prof.dr. R.D. van der Mei
CWI, P.O. Box 94079, 1090 GB Amsterdam.
Phone: 020 – 5924129 E-mail: r.d.van.der.mei@cwi.nl
Prof.dr. M.R.H. Mandjes
Korteweg-de Vries Institute for Mathematics
University of Amsterdam, Science Park 904,1098 XH Amsterdam
Phone: 0 20 - 5255164 E-mail: m.r.h.mandjes@uva.nl

Course RA: Randomized Algorithms

Time: Monday 13.00 – 14.45 (September 12 – November 7).
Location: Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
Lecturers: Dr. R.A. Sitters (VU) and Prof.dr. L. Stougie (VU).

Course description:
The topics are:
- Randomized complexity classes; Yao's minimax principle; Application of probabilistic bounding techniques.
- The probabilistic method; Derandomization; Random walks; Randomized LP algorithms; On-line algorithms.
- Randomization in geometric problems

Literature
R. Motwani and P. Raghavan: Randomized Algorithms, Cambridge University Press, New York, 1995, ISBN 0-521-47465-5. The participants are assumed to have this book at their disposal by buying or lending (e.g. from the university library) the book.

Prerequisites
Elementary knowledge of probability theory.

Examination:
Take home problems.

Address of the lecturers:
Dr.ir. R.A. Sitters
Department of Econometrics and Operations Research , Faculty of Economics & Business Administration, VU University Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam
Phone: 020 – 5989391 E-mail: rsitters@feweb.vu.nl
Course CO2a: Combinatorial Optimization 2a

Time: Monday 15.00 – 16.45 (September 12 – November 7).
Location: Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
Lecturer: Prof.dr. G.J. Woeginger (TU/e)

Course description:
Combinatorial optimization is the investigation of design and planning problems in which discrete decisions must be made. The field originated in the 1950s with the work of Dantzig et al and Gomory on integer linear programming formulations for routing, scheduling and cutting stock problems. Other applications occur, e.g. in facility location, network and circuit design, and biomolecular systems. The course gives an introduction into NP-hardness, and discusses approaches for dealing with NP-hard problems, like: approximation techniques; local search; probabilistic analysis; fixed parameterized tractability; exact algorithms.

Literature:
- In addition, some papers will be provided.

Prerequisites
- Knowledge of basic linear algebra.
- Knowledge of network flow, linear programming and duality as, e.g., in V. Chvatal, Linear Programming, Freeman, 1983.

Examination:
Take-home problems.

Address of the lecturer:
Prof.dr. G.J. Woeginger
Dept. of Mathematics & Computer Science, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven
Phone: 040 – 2472415 E-mail: gwoegi@win.tue.nl URL: www.win.tue.nl/~gwoegi

Course CO2b: “Combinatorial Optimization 2b”

Time: Monday 10.15 – 12.00 (November 14 – December 12 & January 23 – February 13).
Location: Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
Lecturer: Dr. F. Vallentin (TUD)

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 ILPs a perfect tool for formulating problems in combinatorial optimization; many software packages are available for this. The drawback is that solving ILPs 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 ILPs.

The following topics will be treated:
- the expressive power of ILPs in combinatorial optimization
- geometry of integer linear programs: the interplay of polyhedra and lattices
- easy and difficult ILPs
- geometric techniques based on cutting planes
- algebraic techniques based on lattice basis reduction

Literature:
- B. Korte, J. Vygen, Combinatorial Optimization, Theory and Algorithms, Springer 2008 (available online via springerlink)
- A. Schrijver, Theory of Linear and Integer Programming, J. Wiley and Sons Ltd., Chichester, 1986.
**Prerequisites**
- Knowledge of linear algebra.

**Examination:**
Take home problems.

**Address of the lecturer:**
Dr. F. Vallentin
Faculty of Electrical Engineering, Mathematics and Computer Science, Delft University of Technology
Mekelweg 4, 2628 CD Delft
Phone: 015 - 2786262   E-mail: f.vallentin@tudelft.nl

**Course NCG: “Noncooperative games”**

*Location:* Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
*Lecturer:* Dr. F. Thuijsman (UM)

**Course description:**
The course will focus on noncooperative games, one-shot as well as dynamic, in the following order: matrix and bimatrix games, repeated games, specific models of stochastic (Markov) games, evolutionary games. We explore solution concepts like “value” and “optimal strategies” for zero sum games and “equilibrium” for non-zero sum games. 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. Besides, we explore the concepts of “evolutionary stable strategy” and “replicator dynamics” and their relations with models of population dynamics and with models of “learning”. Several examples will be taken from biological settings.

**Literature:**
Lecture notes will be provided.

**Prerequisites:**
Basic knowledge (bachelor level) of analysis and linear algebra.

**Examination:**
Take home problems.

**Address of the lecturer:**
Dr. F. Thuijsman
Dept. of Knowledge Engineering, Maastricht University,
P.O. Box 616, 6200 MD Maastricht
Phone : 043 – 3883489   E-mail : f.thuijsman@maastrichtuniversity.nl

**Course MDP: “Markov Decision Processes”**

*Time:* Monday 15.00 – 16.45 (November 14 - December 12 & January 23 - February 13).
*Location:* Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
*Lecturers:* Dr. S. Bhulai (VU) and Prof.dr. R. Núñez Queija (UvA)

**Course description:**
The theory of Markov decision processes (MDPs) - also known under the names sequential decision theory, stochastic control or stochastic dynamic programming - studies sequential optimization of stochastic systems by controlling their transition mechanism over time. Each control policy defines a stochastic process and values of objective functions associated with this process. The goal is to select a control policy that optimizes a function of the values generated by the utility functions. In real life, decisions that are made usually have two types of impact. Firstly, they cost or save resources, such as money or time. Secondly, by influencing the dynamics of the system they have an impact on the future as well. Therefore, the decision with the largest immediate profit may not be good in view of future rewards in many situations. MDPs model this paradigm and can be used to model many important applications in practice. In this course we provide results on the structure and existence of good policies, on methods for the computation of optimal policies, and illustrate them by applications.

**Contents of the lectures:**
1. Model formulation, policies, optimality criteria, the finite horizon.
2. Average rewards: optimality equation and solution methods.
3. Discounted rewards: optimality equation and solution methods.
4. Structural properties.
5. Applications of MDPs.
6. Further topics in MDPs

**Literature:**
Lecture notes will be provided.

**Prerequisites:**
- Elementary knowledge of linear programming (e.g. K.G. Murty, Linear programming, Wiley, 1983).
- Elementary knowledge of probability theory (e.g. S.M. Ross, A first course in probability, Macmillan, New York, 1976).
- Elementary knowledge of (numerical) analysis (e.g. Banach space; contracting mappings; Newton’s method; Laurent series).

**Examination:**
Take home problems.

**Addresses of the lecturers:**
Dr. S. Bhulai
Department of Mathematics, VU University Amsterdam,
De Boelelaan 1081a, 1081 HV Amsterdam
Phone: 020 – 5987679  E-mail: sbhulai@few.vu.nl  URL: www.math.vu.nl/~sbhulai
Prof.dr. R. Núñez Queija,
Fac. of Economics & Business, Amsterdam University
Valckenierstraat 65-67, 1018 XE Amsterdam
Phone: 020 - 5254378  E-mail: nunezqueija@uva.nl

**Course ORHC: “Operations Research and Health Care”**

**Time**: Monday 10.15 – 12.00 (February 20 – April 2 & April 16 and 23).
**Location**: Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
**Lecturers**: Dr. ir. E.W. Hans (UT), Prof. dr. J.J. van de Klundert (EUR)

**Course description:**
Global and national developments cause the health of populations and individuals to pose new problems for societies and organizations. As expectations rise and populations age, the burden of health care cost becomes increasingly difficult to carry. Society is presented with tough decision problems regarding the efficient, effective and equitable use of scarce resources to improve our precious health. For many of these problems, operations research provides valuable solution methods.
In this course, we start by overviewing topics, methodology, models, and objectives for health care decision making. We subsequently provide an in depth and rigorous mathematical treatment of operations research applications in a variety of prominent domains. Partly, the material will be based on application of classical operations research methods e.g. from combinatorial optimization or queuing theory) to problems in the domain of health care. Another part of the course addresses health care specific problems and methods, which go beyond classical OR applications.
The course will be organized by topic:
-  Health services research methodology
-  Outpatient planning (Queueing, Scheduling)
-  Resource Planning & Scheduling (Scheduling, Branch-and-Price, Stochastic Programming)
-  Human resource planning (Rostering, Crew Scheduling)
-  Health Chain Planning (Supply Chain Planning, Combinatorial Optimization, Queueing)
-  Medical decision making (decision making under uncertainty, utility maximization)
-  Epidemiological models (Markov decision models, sensitivity analysis)
-  Optimization problems in Quality & Safety (Risk modeling, markets)
-  Benchmarking (Data Envelopment Analysis, Stochastic Frontier Analysis)

**Literature:**
- Papers/handouts

**Prerequisites:**
Understanding of queueing theory and combinatorial optimization at M.Sc. level.

**Examination:**
4 take home problems.
Addresses of the lecturers:
Dr. E.W. Hans
University of Twente, Department of Operational Methods for Production and Logistics
P.O. Box 217, 7500 AE Enschede.
Phone: 053 – 4893523   E-mail: e.w.hans@utwente.nl
Prof.dr. J.J. van de Klundert
Erasmus Medical Centre/Erasmus University,
Department Health Care Management, P.O. Box 1738, 3000 DR Rotterdam
Phone: 010 – 4088555   E-mail: vandeklundert@bmg.eur.nl

Course AQT: “Advanced Queueing Theory”

Time       : Monday 13.00 – 14.45 (February 20 – April 2 & April 16 and 23).
Location   : Mathematical Building, Room 611 AB, Budapestlaan, Utrecht (De Uithof).
Lecturer   : Prof.dr.ir. S.C. Borst (TU/e), Prof. dr.ir. O.J. Boxma (TU/e)

Course description:
Complex stochastic systems, like communication systems, computer networks and manufacturing systems, may often be modeled as queueing networks with multiple nodes and/or multiple classes. The performance of these systems may thus be evaluated in terms of queue lengths, sojourn times or blocking probabilities in queueing networks.
Specific topics include (a selection from):
- Analytical-numerical techniques: transform methods, matrix-analytic method, compensation method.
- Polling systems: cycle times, queue lengths, waiting times, conservation laws, service policies, visit orders.
- Performance optimization: achievable delay performance, discriminatory scheduling, age-based scheduling, size-based scheduling, fairness.

Literature
Handouts and slides; useful background material may be found in

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.ir. S.C. Borst
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P.O. Box 513, 5600 MB Eindhoven
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Course ORG: “OR-Games”

Time       : Monday 15.00 – 16.45 (February 20 – April 2 & April 16 and 23).
Location   : Mathematical Building, Room 611AB, Budapestlaan, Utrecht (De Uithof).
Lecturers  : Prof.dr. P.E.M. Borm (UvT) and Prof.dr. H.J.M. Hamers (UvT)

Course description:
The aim of this course is to provide a general overview of the possibilities of analyzing various OR-situations from a game theoretic perspective. A large part of the course is motivated by the idea that joint OR-problems in which various decision makers are involved not only have an optimization aspect in
generating e.g. minimal total joint costs but as an allocation aspect in dividing these costs back fairly to the individuals itself.

Global scheme:
- A global survey of relevant notions from both cooperative and non-cooperative game theory.
- Applications to bankruptcy, cost sharing, fixed and spanning tree, traveling salesman, Chinese postman, assignment, permutation, scheduling, lot sizing and inventory situations.

**Literature**
Course material:
- Handouts will be provided during the course.

**Prerequisites**
The course is intended to be accessible without specific knowledge of game theory. For this aim the first part of the course will survey the game theoretical concepts that are needed.

**Examination:**
One final assignment to model and analyze a self-selected OR problem from a game theoretical perspective.

**Addresses of the lecturers:**
Prof. dr. P.E.M. Borm
CentER for Economic Research, Tilburg University,
P.O. Box 90153, 5000 LE Tilburg
Phone: 013 – 4663026 E-mail: pemborm@uvt.nl URL: http://center.uvt.nl/staff/borm

Prof. dr. H.J.M. Hamers
CentER for Economic Research, Tilburg University,
P.O. Box 90153, 5000 LE Tilburg
Phone: 013 – 4662660 E-mail: h.j.m.hamers@uvt.nl URL: http://center.uvt.nl/staff/hamers
5. Master courses 2011/2012

During the academic year 2011/2012 seven courses will be taught in two semesters; each semester has a duration of 12 weeks. The courses are part of the Dutch Master Programme in Mathematics (http://www.mastermath.nl).

Fall 2011:
- ISP (Introduction to stochastic processes; September 5, 6, 12 and 13);
- CO (Continuous optimization; September 19, October 3, 17, 31, November 14, 28, December 5);
- DO (Discrete optimization; September 19, 26, October 10, 24, November 7, 21, December 5);
- HEU (Heuristic Methods in Operations Research; September 19 – December 5).

Spring 2012 (February 6 – April 2, April 16, 23, May 7):
- ALP (Advanced linear programming);
- SCH (Scheduling);
- QT (Queueing theory).

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Fall 2011*</th>
<th>Spring 2012</th>
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<tbody>
<tr>
<td>11.00 - 11.45</td>
<td>Course CO/DO**</td>
<td>Course ALP***</td>
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<tr>
<td>12.00 - 12.45</td>
<td>Course CO/DO</td>
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<td>12.45 - 13.15</td>
<td>Lunch break</td>
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<td>13.15 - 14.00</td>
<td>Course CO/DO**</td>
<td>Course SCH</td>
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<td>14.15 - 15.00</td>
<td>Course CO/DO</td>
<td>Course SCH</td>
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<tr>
<td>15.15 - 16.00</td>
<td>Course HEU</td>
<td>Course QT</td>
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<tr>
<td>16.15 - 17.00</td>
<td>Course HEU</td>
<td>Course QT</td>
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</table>

* The course ISP is taught on September 5, 6, 12 and 13 (10.15 – 12.00 and 13.00 – 14.45 each day).
** The course CO is taught on September 19 and December 5 from 11.00 – 12.45, and on October 3, 17, 31, November 14, 28 from 11.00 – 12.45 and 13.15 – 15.00.
*** The course DO is taught on September 19 and December 5 from 13.15 – 15.00, and on September 26, October 10, 24, November 7, 21 from 11.00 – 12.45 and 13.15 – 15.00.

*** 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 (Mastermath): http://www.mastermath.nl/locations.

Credits
The credits for students who have passed the exercises successfully are 6 EC per course, except the short course ISP (4 EC).

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 http://www.mastermath.nl.

Course ISP: “Introduction to Stochastic Processes”

Time: 10.15 – 12.00 and 13.00 – 14.45 (September 5, 6, 12 and 13).
Location: Utrecht (De Uithof).
Lecturers: Dr. N. Litvak (University of Twente) and Dr.ir. W.R.W. Scheinhardt (University of Twente).

Aim:
To provide an introduction in the basic notions of stochastic processes as applied in stochastic operations research topics like queueing theory and Markov decision processes.

Description:
The following subjects will be treated:
- Discrete time Markov chains, including classification of states and long run behaviour and branching processes;
- Exponential distribution and Poisson Processes;
- Generating functions and Laplace-Stieltjes transforms;
- Continuous time Markov chains and birth-and-death processes;
- Renewal theory, including renewal theorem, renewal reward processes and regenerative processes.
Literature:
The 9th or 8th edition can also be used. Having the book is essential for the course.

Examination:
Written examination.

Prerequisites:

Addresses of the lecturers:
Dr. W.R.W. Scheinhardt
Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE Enschede
Phone: 053-4893832  E-mail: w.r.w.scheinhardt@utwente.nl  URL: www.math.utwente.nl/~scheinhardtwrw
Dr. N. Litvak
Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE Enschede
Phone: 053-4893388  E-mail: n.litvak@utwente.nl  URL: www.math.utwente.nl/~litvakn

Course CO: “Continuous Optimization”

Time:   Monday 11.00 – 12.45 (September 19, December 5)
        Monday 11.00 – 12.45 and 13.15 – 15.00 (October 3, 17, 31, November 14, 28)
Location:  Utrecht (De Uithof).
Lecturer:  Dr. G.J. Still (University of Twente).

Aim:
The course aims to provide an advanced introduction into the basics and methods of nonlinear continuous optimization (also called nonlinear programming).

Course description:
The course starts with some historical examples and an introduction into convex sets and convex functions.
Then, optimality conditions in unconstrained and constrained optimization are discussed with emphasis on convex problems. Duality in convex optimization is the next topic followed by an introduction into the basic algorithms for unconstrained and constrained problems. Finally as a special topic, LP-, Lagrange- and semidefinite-relaxations of integer programs are studied.

Literature:
- Lecture notes "Nonlinear Optimization", by E. de Klerk, C. Roos, T. Terlaky;

Prerequisites:
Basic knowledge of linear algebra and multivariate analysis.

Examination:
Written examination.

Remark:
More information and study material is to be found at

Address of the lecturer:
Dr. G.J. Still
Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE Enschede
Phone: 053-4893404  E-mail: g.j.still@utwente.nl  URL: http://wwwhome.math.utwente.nl/~stillgi/
Course DO: “Discrete Optimization”

Time: Monday 13.15 – 15.00 (September 19, December 5)
           Monday 11.00 – 12.45 and 13.15 – 15.00 (September 26, October 10, 24, November 7, 21)

Location: Utrecht (Uithof).

Lecturer: Prof.dr. G. Schäfer (VU,CWI).

Aim:
To provide a solid foundation in Discrete Optimization, with an eye on algorithm design and algorithm analysis, including the basics of computational complexity.

Course description:
The aim of the course is to provide a solid foundation in Discrete Optimization. A particular focus will be given to the design and analysis of algorithms and to computational complexity. Discrete Optimization is about the problem of finding a best solution among a set of feasible solutions. The set of feasible solutions might be astronomically large but is assumed to be discrete (finite or countably infinite), which also constitutes the major difference to Continuous Optimization. A notorious example is the traveling salesman problem, where we are asked to find a shortest tour among all tours that visit every node of a given graph exactly once. Yet another example is linear programming, which can be interpreted as the problem of finding a best among a finite number of vertices of a polyhedron. The course introduces some of the most relevant problems from the area, as well as algorithms to solve them.

The following topics will (most probably) be treated
• Introduction to Algorithms & Analysis
• Shortest Path Algorithms
• Minimum Spanning Trees & Matroids
• Maximum Flows & Minimum Cuts
• Minimum Cost Flows
• P, NP, coNP, NP-completeness
• Integer Linear Programming & Total Unimodularity
• Approximation Algorithms
• Primal-Dual Algorithms
• Inapproximability & Approximation Schemes

Literature:
We use a reader with selected chapters from several books listed below. The reader can be purchased in the first lecture. Occasionally additional copies will be distributed (if necessary).

Prerequisites:
Knowledge of linear algebra and graph theory is advantageous.

Examination:
Take home problems (40%) and a written exam (60%).

Address of the lecturer:
Prof.dr. G. Schäfer
CWI, P.O. Box 94079, 1090 GB Amsterdam
Phone: 020 - 592 4165   E-mail: G.Schaefer@cwi.nl   URL: http://www.cwi.nl/~schaefer
**Course HEU “Heuristic Methods in Operations Research”**

**Time**: Monday 15.15 – 17.00 (September 19 – December 5).

**Location**: Utrecht (De Uithof).

**Lecturers**: Prof.dr. J.L. Hurink (University of Twente) and dr. J.M.J. Schutten (University of Twente).

**Aim**: This course gives an overview of heuristic solution methods in combinatorial optimization.

**Description**: Due to the computational complexity of most of the practical relevant optimization problems, heuristic methods form an important class of solution methods for such problems. In this course we give an overview of different classes of heuristic solution approaches and present examples of their application.

In detail, the following issues are treated:
- Sampling based heuristics;
- Restricted dynamic programming;
- Truncated branch and bound/beam search;
- Relaxations/lower bounds;
- Evaluation techniques;
- Local Search;
- Evolutionary methods;
- Hierarchical and decentralized approaches.

**Literature**: Handouts.

**Examination**: Oral or written examination and possibly take home problems.

**Prerequisites**: Basic knowledge (bachelor level) of analysis, linear algebra and linear programming.

**Addresses of the lecturers**:
Prof.dr. J.L. Hurink  
Department of Applied Mathematics, University of Twente, P.O. Box 217, 7500 AE Enschede  
Phone: 053 – 4893447  
E-mail: j.l.hurink@utwente.nl  
URL: www.math.utwente.nl/~hurinkjl

Dr. ir. J.M.J. Schutten  
Department OMPL, University of Twente, P.O. Box 217, 7500 AE Enschede  
Phone: 053 – 4894676  
E-mail: j.m.j.schutten@utwente.nl  
URL: www.mb.utwente.nl/ompl/staff/Schutten/

**Course ALP: “Advanced Linear Programming”**

**Time**: Monday 11.00 – 12.45 (February 6 – April 2, April 16, 23, May 7).

**Location**: Utrecht (De Uithof).

**Lecturers**: Prof.dr. L. Stougie (VU University Amsterdam) and Dr.ir. J.M. van den Akker (Utrecht University).

**Aim**: To provide insight in theory and development of practical methods for basic and advanced linear programming.

**Course description**:
Part 1: Basic theory and algorithms of linear optimization:
- Linear optimization; polyhedra and polytopes; the simplex algorithm; duality; linear inequalities and Farkas’ lemma; sensitivity analysis.

Part 2: Advanced linear optimization methods:
- The revised simplex method and column generation; Dantzig-Wolfe- and Benders’ decomposition; network flow problems; the ellipsoid method; an interior point method; integer programming formulations and solution methods.

**Literature**:  

**Prerequisites**:  
Basic knowledge (bachelor level) of linear algebra and graph theory.
Examination:
Written examination.

Addresses of the lecturers:
Prof. dr. L. Stougie
Department of Econometrics and Operations Research
Faculty of Economics & Business Administration, VU University Amsterdam
De Boelelaan 1105, 1081 HV Amsterdam
Phone: 020 – 5989391  E-mail: lstougie@feweb.vu.nl

Dr. ir. J.M. van den Akker
Departement Informatica, Utrecht University, P.O. Box 80089, 3508 TB Utrecht
Phone: 030-2533989  E-mail: marjan@cs.uu.nl  URL: http://people.cs.uu.nl/marjan/

Course SCH: “Scheduling”

Time : Monday 13.15 – 15.00 (February 6 – April 2, April 16, 23, May 7).
Location: Utrecht (De Uithof).
Lecturer: Dr. T. Vredeveld (Maastricht University)

Aim: This course gives an introduction into scheduling theory and its applications.

Course description:
The term scheduling represents the assignment of resources over time to perform tasks, jobs or activities. Feasible schedules are compared with respect to a given optimality criterion. Mostly, the optimization problem is combinatorial and very complex. From a computational point of view many of these problems are hard (NP-hard). In this course an overview on the most classical scheduling models is given and exact as well as some optimal and some heuristic solution methods are discussed for these models. In detail, the following issues are treated:
- Classification of scheduling models
- Single-machine models
- Parallel-machines models
- Open shop, flow shop and job shop models
- Timetabling
- Transportation
- On-line models.

Literature:
- Handout for special subjects.

Prerequisites:
Basic knowledge (bachelor level) of analysis and linear algebra.

Examination:
Take home problems and an examination (oral or written).

Address of the lecturer:
Dr. T. Vredeveld
School of Business and Economics, Department of Quantitative Economics, Maastricht University
P.O. Box 616, 6200 MD Maastricht
Phone: 043-3883911  E-mail: t.redevelt@maastrichtuniversity.nl  URL: http://www.personeel.unimaas.nl/t.vredeveld
Course QT: “Queueing Theory”

Time: Monday 15.15 – 17.00 (February 6 – April 2, April 16, 23, May 7).
Location: Utrecht (De Uithof).
Lecturers: Prof.dr.ir. I.J.B.F. Adan (Eindhoven University of Technology) and Dr. J.A.C. Resing (Eindhoven University of Technology).

Aim:
To provide insight in the theory of queueing models.

Course description:
The following subjects will be treated:
- Fundamental queueing relations (Little's law, PASTA property);
- Markovian queues (M/M/1 queue, M/M/c queue, M/E_r/1 queue);
- M/G/1 queue and G/M/1 queue;
- Mean value technique;
- Priority queues;
- Variations of the M/G/1 queue;
- Insensitive queues (M/G/c/c queue and M/G/infinity queue).

Literature:

Prerequisites:

Examination:
Written examination.

Address of the lecturer:
Prof.dr.ir. I.J.B.F. Adan
Dept. of Mechanical Engineering, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven
Phone: 040-2472932 E-mail: iadan@tue.nl
Dr. J.A.C. Resing
Dept. of Mathematics & Computer Science, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven
Phone: 040-2472984 E-mail: resing@win.tue.nl
6. Financial regulations

LNMB

The following arrangements hold.

1. Only PhD students who are preparing their thesis under supervision of a member of the LNMB (see the list in paragraph 12 of this booklet) are considered for financial aid.
2. The LNMB does not pay the PhD students directly; the payment will be done afterwards to the administration of the university of the PhD student. In order to receive the payment, a form has to be submitted. These forms are available at the LNMB secretary.
3. Reimbursements are intended for education activities such as courses and workshops.
   For participation in courses, 50% of the price of a second class train return ticket between the university location and Utrecht is reimbursed.
   For participation in the Lunteren conference there can be given a compensation for lodging with a maximum of 50 euro per conference or workshop.
4. The other expenses will be accounted to the PhD students or their universities.

NWO

NWO provides grants for research. There are grants for working visits and for attending conferences. Information about these grants can be requested from NWO, phone: 070 - 3440624 (Grant Program Office).

NUFFIC

The Netherlands has cultural accords with various countries, which include arrangements for scientific cooperation and exchange. Scientific staff can obtain, under special conditions, a grant for short visits to other countries. The money originates from the Ministry OCW (Education, Culture and Science). NUFFIC takes care of the formalities. See also www.nuffic.nl/studie/beursopener.html

OTHER GRANTS

For information about other grants we refer to the administration of your own university. See also www.vsnu.nl
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<td>J.F. Sturm †</td>
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<td>M.H. van der Vlerk</td>
<td>I. Vliegen</td>
<td>A. van Vliet</td>
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<td>J.P.A. van Vliet</td>
<td>Y. Volkovich</td>
<td>T. Vredevelde</td>
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<td>M.J.C.M. Vromans</td>
<td>M. van Vuuren</td>
<td>X. Wang</td>
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<td>M. Wennink</td>
<td>W. van der Weij</td>
<td>A.C.C. van Wijk</td>
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<td>R. Wildeman</td>
<td>E.M.M. Winands</td>
<td>R. Yang</td>
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<td>Z. Yang</td>
<td>T. Yuan</td>
<td>M.E. Zonderland</td>
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<tr>
<td>C.M. Zwaneveld</td>
<td>A.P. Zwart</td>
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</tr>
</tbody>
</table>
8. Structuurschets interne organisatie LNMB (in Dutch)

Vastgesteld in de algemene ledenvergadering van 16 januari 1991, aangepast in de algemene ledenvergaderingen van 16 januari 2007 en 18 januari 2011

0. Preambulé
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 tweede-fase onderzoekersopleiding in de mathematische besliskunde verzorgt. Door landelijke bundeling van internationaal erkende expertise en door inzet van voorraadstaande 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 tweede fase opleidingen.

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 tenminste \( n \) 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 tenminste 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 Wetenschappelijk 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 Wetenschappelijk 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

De leden van het Dagelijks Bestuur, m.u.v. de directeur, hebben een zittingstermijn van 4 jaar. Jaarlijks treedt tenminste één lid af. Aftredende leden zijn éénmaal herkiesbaar.

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 Wetenschappelijk Directeur bij diens taakuitvoering;
5. **Wetenschappelijk Directeur**


De Wetenschappelijk 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 Wetenschappelijk 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 Wetenschappelijk 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.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Institution</th>
<th>Research Theme</th>
<th>Projectleader(s)</th>
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<td>Algorithms, Combinatorics and Optimization</td>
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<tr>
<td>1b.</td>
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<td>Van der Mei</td>
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<td>2.</td>
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<td>UvT</td>
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<td>Van Dam</td>
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<td>8a.</td>
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<td>Deterministic and Stochastic Operations Research</td>
<td>Van Dijk</td>
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<td>Balder</td>
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<td>Stougie/Tijms</td>
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<td>13b.</td>
<td>VU</td>
<td>Optimization of business processes</td>
<td>Koole</td>
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</table>

Project 1a. Centre for Mathematics and Computer Science (CWI)
 Algorithms, Combinatorics and Optimization

Leader: Prof.dr. M. Laurent.
Address: Centre for Mathematics and Computer Science, Science Park 123, 1098 XG Amsterdam.
Phone: 020 - 5924105; 020 - 5924189 (secretary).

Research themes:
1. Combinatorics and optimization;
2. Algorithmic game theory.

Project 1b. Centre for Mathematics and Computer Science (CWI)
 Probability and Stochastic Networks

Leader: Prof.dr. R.D. van der Mei and Prof.dr. A.P. Zwart.
Address: Centre for Mathematics and Computer Science, Science Park 123, 1098 XG Amsterdam.
Phone: 020 - 5924129; 020 - 5924199 (secretary).
Research staff: Prof.dr. J. van den Berg (0.8), Drs. A.V. den Boer (1.0), Drs. J.W. Bosman (1.0), Drs. M. van Buuren (1.0), Drs. S. Ding (1.0), Drs. J.P. Dorsman (0.6), Dr. K. Dzhiparidze (1.0), Dr. A. Fey (0.5), Drs. M. Frolkova (1.0), Ir. G.J. Hoekstra (0.2), Drs. D. Kiss (1.0), Dr. M.N.M. van Lieshout (1.0), Prof.dr. R.D. van der Mei (0.8), Prof.dr. R. Nunez-Queija (0.2), Drs. M. Onderwater (1.0), Dr. O. Perry (1.0), Dr. F. Simatos (1.0), Drs. K. Turkyilmaz (1.0), Prof.dr. A.P. Zwart (1.0).

Research themes:
1. Performance analysis of communication systems;
2. Spatial stochastics and stochastic processes;
3. Stochastic geometry.

Project 2. Erasmus University Rotterdam
 Operations Research

Leader: Prof.dr.ir. R. Dekker.
Address: Econometric Institute, H11-33, Erasmus University Rotterdam, Postbus 1738, 3000 DR Rotterdam.
Phone: 010 – 4081274; 010 – 4081264 (secretary).

Research themes:
1. Railway operations optimization (Budai, Dekker, Huisman, Potthoff, Wagelmans);
2. Maintenance and reliability analysis (Dekker, Budai, Frenk, Nicolai);
3. Revenue management (Dekker, Budai, Frenk, Pak);
4. Production planning and inventory control (Dekker, Van de Heuvel, Retel-Helmrich, Wagelmans);
5. Service Logistics (Dekker, Pince, Pourakbar);
6. Lotting strategies in Combinatorial Auctions (Dekker, Kaymak, Waltmans);
7. Container and intermodal logistics (van Asperen, Dekker, Pourakbar);
8. OR in Medical Decision Making (Dekker);
9. Reverse logistics (Dekker, van de Heuvel, Pince);
10. Location and network problems (Mulder).

Project 3. Wageningen University
Operations Research and Logistics Group
Leader: Prof.dr.ir. J.G.A.J. van der Vorst.
Address: Hollandseweg 1, 6706 KN Wageningen.
Phone: 0317 – 485645.

Research themes:
1. Quality controlled logistics
   - using advanced product quality information in logistics decision making for improved customer service and less food spoilage
2. Sustainable logistics
   - socio-economic and environmental performance measures, trade-offs to improve overall sustainable performance in agrifood chains
3. Planning and Inventory Control
   - production and inventory models for perishable products
   - models and algorithms for valorisation and robust design

Project 4a. Tilburg University
Operations Research
Leader: Prof.dr.ir. E.R. van Dam
Address: Department of Econometrics and Operations Research, CentER for Economic Research, School of Economics and Management, Tilburg University, P.O. Box 90153, 5000 LE Tilburg.
Phone: 013 – 4662430

Research themes:
1. Stochastic Operations Research;
2. Deterministic Operations Research;
3. Simulation;
4. Combinatorial mathematics;
5. Cooperative game theory.
Project 4b. Tilburg University
Operations Research and Game theory

Leaders: Prof.dr. P.E.M. Borm.
Address: Department of Econometrics and Operations Research, CentER for Economic Research, Tilburg School of Economics and Management, Tilburg University, P.O. Box 90153, 5000 LE Tilburg.
Phone: 013 - 4663026; 013 - 4662340 (secretary).

Research themes:
1. Cooperative game theory;
2. Non-cooperative game theory;
3. Mathematical economics;
4. Skill in games;
5. Overt and covert network analysis.

Project 5a. Maastricht University
Combinatorial optimization

Leader: Prof.dr.ir. C.P.M. van Hoesel.
Address: Department of Quantitative Economics, Faculty of Economics, Maastricht University, P.O. Box 616, 6200 MD Maastricht.
Phone: 043 - 3883727; 043 - 3883835 (secretary).
Research staff: Dr. A. Berger, dr. A. Grigoriev, prof.dr.ir. S. van Hoesel, prof.dr. R. Müller, dr. H. Röglin and dr. T. Vredeveld.

Research themes:
1. Mechanism design, combinatorial auctions;
2. Network optimization;
3. Planning and scheduling;
4. Approximation;
5. Pricing, Revenue Management;

Project 5b. Maastricht University
Game Theory and Optimization

Leader: Dr. F. Thuijsman.
Address: Department of Knowledge Engineering, Maastricht University, P.O. Box 616, 6200 MD Maastricht.
Phone: 043 - 3883489; 043 - 3883496 (secretary).

Research themes:
1. Strategic optimization in networks (network formation games, Markov games, gene networks, phylogenetic networks, evolutionary models)
2 Systems biology (signal processing, data mining, pattern recognition, computability).

Project 6. University of Groningen
Operations Research

Leader: Prof.dr. R.H. Teunter.
Address: Faculty of Economics and Business, University of Groningen, P.O. Box 800, 9700 AV Groningen.
Phone: 050 - 3638617; 050 - 3637491 (secretary).
Research themes:
1. Decision making under uncertainty and Stochastic programming (Klein Haneveld, Streutker, van der Vlerk).
2. Combinatorial optimization and quantitative logistics (Bouma, Goldengorin, Roodbergen, Schakel, Sierksma, Talsma, Teunter, Vis)
3. Reverse logistics, Inventory control, forecasting, pricing and revenue management (Bodea, Caner, Teunter, Zhu)

Project 7. University of Leiden
Stochastic Operations Research

Leader: Dr. F.M. Spieksma.
Address: Mathematical Institute, University of Leiden, P.O. Box 9512, 2300 RA Leiden.
Phone: 071 – 5277128.
Research staff: Drs H. Blok, dr. F.M. Spieksma.

Research themes:
1. Markov decision chains with applications in queueing networks;
2. Markov games;
3. Stability properties of parametrised collections of Markov chains with applications to queueing.

Project 8a. Delft University of Technology
Interior point methods

Leader: Prof.dr.ir. C. Roos
Address: Faculty of Electrical Engineering, Mathematics and Computer Science,
Delft University of Technology, Mekelweg 4, 2628 CD Delft
Phone: 015 - 2782530; 015 - 2787486 (secretary)
Research staff: A. Asadi MSc., ir. H.N. Post, B.P. Silalahi MSc. and M. Zangiabadi MSc.

Research themes:
1. Interior point methods for linear and non-linear optimization;
2. Randomized (approximation) algorithms;
3. Robust optimization.

Project 8b. Delft University of Technology
Interior point methods

Leader: Prof.dr.ir. K.I. Aardal
Address: Faculty of Electrical Engineering, Mathematics and Computer Science,
Delft University of Technology, Mekelweg 4, 2628 CD Delft
Phone: 015 - 2785093; 015 - 2784109 (secretary)
DeCorte, F. von Heymann,, S. Li, H. Post

Research themes:
1. Integer and combinatorial optimization;
2. Semidefinite/convex optimization;
3. Harmonic analysis applied to optimization, lattices and optimization.

Project 9a. Eindhoven University of Technology
Combinatorial optimization

Leaders: Prof.dr. G.J. Woeginger.
Address: Department of Mathematics and Computer Science, Eindhoven University of
Technology, P.O. Box 513, 5600 MB Eindhoven
Phone: 040 - 2472412 (Woeginger); 040 - 2473130 (secretary)
Research staff: Dr. N. Basal, drs. C.E.J. Eggermont, M. Firat MSc., dr.ir. C.A.J. Hurkens, dr. J.C.M.

Research themes:
1. Combinatorial optimization;
1.1. Graph and matroid structure theory;
1.2. Complexity and approximation;
1.3. Enumerative optimization;
1.4. Optimization under uncertainty;
Project 9b. Eindhoven University of Technology
Stochastic Operations Research

Leaders: Prof.dr.ir. O.J. Boxma.
Address: Department of Mathematics and Computer Science, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven
Phone: 040 - 2472858 (Boxma); 040 - 2473130 (secretary)

Research themes:
1. Stochastic operations research;
   1.1. Random walks and queueing theory;
   1.2. Performance analysis of computer- and communication systems;
   1.3. Performance analysis in operations management and logistics;
2. The EURANDOM program on Queueing and Performance Analysis.

Project 10. University of Amsterdam
Deterministic and Stochastic Operations Research

Leader: Prof.dr. N.M. van Dijk.
Address: Department of Econometrics, Faculty of Economics and Econometrics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam.
Phone: 020 - 5254215; 020 - 5254217 (secretary)
Research staff: Drs. A. Al-Ibrahim, Prof.dr. N.M. van Dijk, dr. C.W. Duin, ir. J.A.M.Hontelez, drs. P. Joustra,
dr. H.J.J. van der Sluis, dr. A. Volgenant and prof.dr.ir. J. van der Wal.

Research themes:
1. Markov decision theory (Al-Ibrahim, Haijema, van der Wal, van Dijk);
2. Performance analysis of service networks (van Dijk, van der Sluis);
3. Exact and bounding results for queueing networks (van Dijk);
4. Scheduling algorithms and complexity (Duin, van der Sluis);
5. Traveling salesman problem and variants (Volgenant);
6. Graph theory problems (Duin, Volgenant);
7. Polyhedral methods (Volgenant);
8. Inventory models (van der Sluis, van der Wal);
9. Transportation (Al-Ibrahim, Haijema, van Dijk, van der Wal);
10. Daily life applications of stochastic models (van Dijk, van der Sluis);
11. Healthcare (Haijema, Hontelez, van Dijk, van der Wal);
12. OR and simulation (van Dijk, van der Sluis, van der Wal);
13. OR and simulation (van Dijk, van der Sluis).

Project 11. University of Twente
Discrete Optimization and Stochastic Operations Research

Leaders: Prof.dr. R.J. Boucherie and prof.dr. M. Uetz.
Address: Faculty of Electrical Engineering, Mathematics & Computer Science, University of Twente, P.O. Box 217, 7500 AE Enschede.
Phone: 053- 4893433; 053- 4893434 (secretary).
Research staff: F. Ahmed MSc, N. Baer MSc, ir. M.J. Bomhoff, M.G.C. Bosman MSc, H.C.M. Bossers MSc, prof.dr. R.J. Boucherie, A. Braaksma MSc, prof.dr.ir. H.J. Broersma, Y. Chen MSc, dr.ir. T.S.H. Driessen, dr. G. Post, X. Qiu MSc, D. Reijsbergen MSc, dr. W. Scheinhardt, dr. G. J. Still, prof.dr. M. Uetz, dr. P. Vanberkel, dr. J.B. Vink-Timmer, J. Wu MSc, M. Zonderland MSc and A. Zwartjes MSc

Research themes:
1. Discrete Mathematics, Mathematical Programming and Stochastic Operations Research:
   - Combinatorial optimization, approximation algorithms, online algorithms, continuous optimization, graph theory, scheduling, timetabling, routing, pricing.
2. Game Theory:
   - Cooperative game theory, noncooperative game theory, stochastic game theory, algorithmic game theory, mechanism design.
3. Stochastic Operations Research:
   - Telecommunication systems, queuing network analysis, large deviations, fluid models, pricing, wireless
     networks, IP networks.
4. Supply chain management:
   - Manufacturing, scheduling, logistics, inventory models, reliability, maintenance, spare parts planning
     and control.
5. Health care logistics.

**Project 12. University of Utrecht**

**Operations Research**

*Leader*: Prof.dr.ir. E.J. Balder  
*Address*: Department of Mathematics, University of Utrecht, Budapestlaan 6, 3508 TA Utrecht.  
*Phone*: 030 - 2531458; 030 - 2531420 (secretary)  
*Research staff*: Prof.dr.ir. E.J. Balder and dr. A. Gnedin.  

*Research themes:*
1. Generalized solutions in game theory, optimal control and mathematical economics;  
2. Probabilistic methods in combinatorics;  
3. Search and sorting algorithms.

**Project 13a. VU University Amsterdam**

**Combinatorial Optimization and Stochastic Operations Research**

*Leaders*: Prof.dr. L. Stougie  
*Address*: Department of Econometrics and OR, VU University Amsterdam,  
           De Boelelaan 1105, 1081 HV Amsterdam  
*Phone*: 020 - 5986013  
*Research staff*: Dr. G.J. Franx, prof.dr. J. Gromicho, dr. B. Heidergott, B. Kaynar MSc.,  
                   Sitters, S.L. van der Ster, MSc, prof.dr. L. Stougie, prof.dr. G.T. Timmer and W. Wolk-  
                   Makarewicz MSc.  

*Research themes:*
1. Combinatorial Optimisation;  
2. Algorithms: complexity and approximation;  
3. Algorithmic game theory;  
4. Computational biology;  
5. Stochastic Operations Research;  
6. Markov decision algorithms for controlled queueing systems;  
7. Analysis and simulation of probabilities for rare events;  
8. Perturbation analysis and simulation techniques;  
9. Numerical algorithms based on Taylor series expansion;  
10. Stochastic programming.

**Project 13b. VU University Amsterdam**

**Optimization of Business Processes**

*Leader*: Prof.dr. G.M. Koole  
*Address*: Department of Mathematics, VU University Amsterdam,  
           De Boelelaan 1081a, 1081 HV Amsterdam  
*Phone*: 020 - 4447755  
                  Kommer, prof.dr. R.D. van der Mei, ir. R. Meijer, drs. D. Moeke, drs. A. Roubos, and  
                  prof.dr. A.P. Zwart.  

*Research themes:*
1. Performance modeling of communication systems;  
2. Theory and applications of controlled queueing systems.
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<th>No.</th>
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<th>Department/Institute</th>
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<td>School of Management and Governance</td>
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<td>Faculteit EWI</td>
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<td>Dep. Logistics, Decision and Information Sciences</td>
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<td>Management and Governance</td>
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36 Dorsman, Jan-Pieter Eindhoven University of Technology
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45 Frolkova, M. CWI
46 Gaast, Drs Jelmer van der Erasmus University Rotterdam, Rotterdam School of Management / Management of Technology and Innovation
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105 Pieters, Angèle Tilburg University
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supply chain consulting
118 Sever, Derya Eindhoven University of Technology
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119 Sharypova, Kristina Eindhoven University of Technology
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Johann Bernoulli Institute for Mathematics and Computer Science
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124 Tas, MSc. D. Eindhoven University of Technology
Pav F10
125 Timmer, M. University of Twente
Vakgroep FMT
126 Truetsch, Uwe Tilburg University
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11. List Alumni LNMB

1. Aarts, Dr.ir. H.F.M.
2. Agatz, Dr.ir. N.A.H. (University of Twente)
3. Akker, Dr.ir. J.M. van den (Maastricht University)
4. Al-Ibrahim, Drs. A. (Maastricht University)
5. Angün, MSc. M.E. (Galatasaray University)
6. Asadi, A. (Goudappel Coffeng)
7. Baarsma, Ir. H.E. (Goudappel Coffeng)
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62 Garbe, Dr. R. Hochschule Bremerhaven
63 Ge, L. Wageningen UniversityWageningen University
64 Gellekom, Dr. J.R.G. van Centraal Beheer Achmea
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## 12. Members

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