Business Analytics and Operational Research

Business Analytics and Operational Research	
Offered by	Department Tilburg University
Language	English
Primarily interesting for	All students, but most relevant for students with background in Major Data Science
Prerequisites	Required courses: Data Statistics (JBM010), Calculus Recommended courses: Linear Algebra
Contact person	jbds@tilburguniversity.edu

Content and composition

Course code	Course name	Level classification
JBM060	Mathematical Analysis and Probability Theory	2.
JBM035	Linear optimization for data science	2.
JBM080	Advanced mathematics 2 for data science	3.
JBM090	Combinatorial optimization for data science	3.
JBM100	Stochastic optimization models for data science	3.

Course description

Note 1: **Please note that this minor takes place in Tilburg.** If you are a bachelor Data Science student you need to register for this course by sending an email to jbds@tilburguniversity.edu.
For non-Data Science students: to participate in these courses you need to register as an individual 'bijvak' student at Tilburg University Initial registration - minors | Tilburg University.
Note 2: select at least 3 out of these 5 courses (at least 15 ECTS).
Note 3: the Calculus and Data Statistics courses must be passed to do this minor (applies to all students, including non-DS students).
Note 4: Passing Linear Algebra is strongly recommended.
Note 5: if you wish to advance to the master Business Analytics and Operations Research after your bachelor you must have successfully completed all 5 electives.

Mathematical Analysis and Probability Theory
One objective of this course is to provide students with a basis of the mathematical theory of functions of one variable. Students do not only need to be able to apply this theory, but also need to understand the fundamentals behind it in order to be capable to understand and develop more advanced mathematical techniques. The goal of acquiring this theory is twofold. First, students dispose in this way of a mathematical analytical basis with which they can model and investigate practical problems in data science. Second, this theory serves as prerequisites for other courses in the program. Another objective is to provide students with the mathematical model of probability. Students need to be able to calculate (conditional) probabilities. Moreover, they can use combinatorics and set theory and apply these in probability theory. Students can work with discrete and continuous random variables and know the specifics of the most commonly used classes of univariate distributions. Finally, they can calculate expectation, variance, moments and moment generating functions of random variables.

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Linear optimization for data science
Linear optimization is one of the fundamental computational tools in Operations Research, and is used for airline scheduling, production planning, and in many other industrial settings. In fact, it has been called one of the mathematical problems “using up most of the computer time in the world”. We will first look at how linear optimization models arise from practical decision problems. Next we will consider the links with linear algebra and geometry. This will lead us to an algorithm, called the simplex method, which may be implemented using techniques from linear algebra. Every linear optimization problem has an associated dual problem, that has an economic interpretation in terms of “shadow prices”, and we will look at these ideas in some detail. Finally, we will consider the case where the decision variables should take integer values, and study two techniques for such problems, namely branchand-bound.

Advanced mathematics for data science
The objective of this course is to provide students with a basis of the mathematical theory of functions of several variables. Students do not only need to be able to apply this theory, but also need to understand the fundamentals behind it in order to be capable to understand and develop more advanced mathematical techniques. The goal of acquiring this theory is twofold. First students dispose in this way of a mathematical analytical basis with which they can model and investigate practical problems in data science. Second, this theory serves as prerequisites for other courses in the program.

Combinatorial optimization for data science
Combinatorial optimization consists on finding an optimal solution among a finite set of possible solutions. The main objectives of the course are to understand the complexity of different combinatorial optimization problems, and to learn different solution methods for such problems. For some problems (the 'easy' problems) fast solution methods exist while for other problems (the 'difficult' problems) finding the optimal solution is time consuming and only practical achievable if the problem is 'small'. For the difficult problems one often has to use Heuristics, which apply "rules of thumb" to find solutions, without any guarantee in the optimality or quality of them. Yet, given the complexity of some problems, heuristics might be the only real option to solve a problem. Also, heuristic methods have proven to be very successful in solving some problem classes.

Stochastic optimization models for data science
The objective of this course is to increase the capability of analyzing managerial problems under uncertainty which occur, for example, in inventory and production control, telecommunications, maintenance, and insurance. This course deals with some of the techniques for modeling and optimizing systems under uncertainty. The emphasis is on providing insight in the theory, on formulating an economic situation into a mathematical model and on providing practical examples in which the discussed models can be applied.