Freie Universität Berlin
(for the Osteuropa-Institut)

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# Optimization methods, rationality
# and decision making in the social sciences

**Language:**     English

**Lecture:**      (2 hours) x 8

**Seminar:**      (2 hours) x 8

## Review

This course aims introducing students to the sphere of applying optimization methods and models in modern economic research.

This course focus on problems:
- classical and modern spheres of application of optimization approaches and operation research in the economy;
- advanced (in comparison to the basic classical approaches) models and methods for solving optimization problems;
- the advantages of optimization approaches to the economic problem;
- objective limitations of the possibilities of optimization concepts in conducting economic research;
- the problems of practical implementation of optimization methods
- modern optimization software.

Some classes include 'discussion session' where students should express their opinion on the properties and prospects of the optimization models and methods.
During the semester, students at seminars perform practical tasks (under the guidance of a tutor with possible completion as individual work). These tasks are intended for practical application of optimization methods, which are considered in lectures.
The final task, assuming the application of one of the studied optimization methods for a specific type of problem.

## Grade

60% - student's presentations and activity during the class; 40% - final task.

## Basic Literature

Hillier Fr. *Introduction to Operations Research* (diff. editions).
Taha Hamdy A. 2006. (first publ. 1976) *Operations Research: An Introduction*. Prentice Hall.

Winston W.L., Goldberg J. B. 2004. *Operations Research: Applications and Algorithms.* Thomson Brooks.

## Prerequisites

The default is students have basic knowledge of calculus and simplest methods for solving optimization problems. First of all, the basics of linear programming. However, the basic questions will be partially repeated at the start-up lectures and seminars.

## Course Topics

**Topic 1:** **Operation research, optimization approaches and rationality concepts in modern economic research.**

    (1)    Williams H. Paul. (1999) *Model Building in Mathematical Programming.* Wiley.
    (2)    Bender Edward A. (2000, first publ. 1991) *An Introduction to Mathematical Modeling.* Dover Publications.
    (3)    Hassan Qudrat-Ullah (Editor), J. Michael Spector (Editor) and oth. (2010) *Complex Decision Making: Theory and Practice.* Springer.

**Topic 2:** **Theoretical aspects of linear programming. The duality theory and its economic interpretation.**

    (1)    Rader David J. (1999) *Deterministic Operations Research: Models and Methods in Linear Optimization.* Wiley.

**Topic 3:** **Analysis of the parametric sustainability of the solutions of optimization problems. Parametric programming. Parametric study of linear programming problems.**

    (1)    Gal Th. (1995) *Postoptimal analyses, parametric programming, and related topics.* Berlin, NewYork.
    (2)    Zlobec S. (2001) *Stable parametric programming.* Springer Science.

**Topic 4:** **Non-linear optimization problems in the economy and methods for their solution.**

    (1)    Lawden D.F. (2006) *Analytical Methods of Optimization.* Dover Publications.
    (2)    Chong Edwin K.P., Zak Stanislaw H. (2008) *An Introduction to Optimization.* Wiley-Interscience.

**Topic 5:** **The problems of discrete optimization in the economy. Methods for solving discrete and integer programming problems.**

    (1)    Papadimitriou C. H. (1998) *Combinatorial Optimization: Algorithms and Complexity.* Dover Publications.
    (2)    Wolsey L.A. (2006) *Production Planning by Mixed Integer Programming.* Springer.
    (3)    Bertsimas D., Weismantel R. (2005) *Optimization Over Integers.* Dynamic Ideas.

**Topic 6:** **Dynamic programming methods and their economic applications.**

    (1)    Hubert L., Arabie P., Meulman J. (1987) *Combinatorial Data Analysis: Optimization by Dynamic Programming.* Society for Industrial and Applied Mathematics (SIAM).
    (2)    Bertsimas D. (2017) *Dynamic Programming and Optimal Control.*

(3)     Lucian Buşoniu L. and oth. (2010) *Reinforcement Learning And Dynamic Programming Using Function Approximators (Automation And Control Engineering).* CRC Press.

## Topic 7:   Relationship between optimization and game-theoretic problems. Economic interpretations.

(1)     Petrers H. (2008) *Game Theory: A Multi-Leveled Approach*. Springer-Verlag Berlin Heidelberg.
(2)     Moulin H. (1998) *Axioms of Cooperative Decision Making*. Monograph of the Econometric Society, Cambridge University Press, Cambridge, Mass.
(3)     Aumann R.J. (1989) *Lectures on Game Theory*. San Francisco. Westview Press.
(4)     Aumann R.J. (1996) *Rationality and Bounded Rationality*.Nancy Schwartz Lecture. Kellog Foundation.
(5)     Maschler M.*The Bargaining Set, Kernel and Nucleolus*. Chapter 18. *Handbook of Game Theory //* R. Aumann and S. Hart (eds.). Elsevier.

## Topic 8:   The problems of rational distribution in the economy. Rationing models and Fair Division.

(1)     Moulin H. (1998) *Axioms of Cooperative Decision Making*. Monograph of the Econometric Society, Cambridge University Press, Cambridge, Mass.
(2)     Moulin H. (2003) *Fair Division and Collective Welfare*. MIT Press, Cambridge, Mass.
(3)     Procaccia A. (2013) *Cake Cutting: Not Just Child`s Play*. Communications of the ACM, Vol. 56 No. 7, Pages 78-87, 10.1145/2483852.2483870