

Springer Monographs in Mathematics

Viorel Barbu  
Teodor Precupanu

# Convexity and Optimization in Banach Spaces

*Fourth Edition*

 Springer

# Convexity And Optimization In Banach Spaces

**V. Barbu, Th. Precupanu**



## **Convexity And Optimization In Banach Spaces:**

**Convexity and Optimization in Banach Spaces** Viorel Barbu, Theodor Precupanu, 1978 *Convexity and Optimization in Banach Spaces* Viorel Barbu, Teodor Precupanu, 2012-01-03 An updated and revised edition of the 1986 title *Convexity and Optimization in Banach Spaces* this book provides a self contained presentation of basic results of the theory of convex sets and functions in infinite dimensional spaces The main emphasis is on applications to convex optimization and convex optimal control problems in Banach spaces A distinctive feature is a strong emphasis on the connection between theory and application This edition has been updated to include new results pertaining to advanced concepts of subdifferential for convex functions and new duality results in convex programming The last chapter concerned with convex control problems has been rewritten and completed with new research concerning boundary control systems the dynamic programming equations in optimal control theory and periodic optimal control problems Finally the structure of the book has been modified to highlight the most recent progression in the field including fundamental results on the theory of infinite dimensional convex analysis and includes helpful bibliographical notes at the end of each chapter

**Convexity and Optimization in Banach Spaces** V. Barbu, Th. Precupanu, 2014-08-15 [Convexity and optimization in Banach spaces](#) V. Barbu, Th. Precupanu, 2014-09-12

**Totally Convex Functions for Fixed Points Computation and Infinite Dimensional Optimization** D. Butnariu, A.N. Iusem, 2012-12-06 The aim of this work is to present in a unified approach a series of results concerning totally convex functions on Banach spaces and their applications to building iterative algorithms for computing common fixed points of measurable families of operators and optimization methods in infinite dimensional settings The notion of totally convex function was first studied by Butnariu, Censor and Reich [31] in the context of the space  $l^{\infty}$  because of its usefulness for establishing convergence of a Bregman projection method for finding common points of infinite families of closed convex sets In this finite dimensional environment total convexity hardly differs from strict convexity In fact a function with closed domain in a finite dimensional Banach space is totally convex if and only if it is strictly convex The relevancy of total convexity as a strengthened form of strict convexity becomes apparent when the Banach space on which the function is defined is infinite dimensional In this case total convexity is a property stronger than strict convexity but weaker than locally uniform convexity see Section 1.3 below The study of totally convex functions in infinite dimensional Banach spaces was started in [33] where it was shown that they are useful tools for extrapolating properties commonly known to belong to operators satisfying demanding contractivity requirements to classes of operators which are not even mildly nonexpansive

**Optimization in Function Spaces with Stability Considerations in Orlicz Spaces** Peter Kosmol, Dieter Müller-Wichards, 2011 This is an essentially self contained book on the theory of convex functions and convex optimization in Banach spaces with a special interest in Orlicz spaces Approximate algorithms based on the stability principles and the solution of the corresponding nonlinear equations are developed in this text A synopsis of the geometry of Banach spaces

aspects of stability and the duality of different levels of differentiability and convexity is developed. A particular emphasis is placed on the geometrical aspects of strong solvability of a convex optimization problem; it turns out that this property is equivalent to local uniform convexity of the corresponding convex function. This treatise also provides a novel approach to the fundamental theorems of Variational Calculus based on the principle of pointwise minimization of the Lagrangian on the one hand and convexification by quadratic supplements using the classical Legendre-Riccati equation on the other. The reader should be familiar with the concepts of mathematical analysis and linear algebra. Some awareness of the principles of measure theory will turn out to be helpful. The book is suitable for students of the second half of undergraduate studies and it provides a rich set of material for a master course on linear and nonlinear functional analysis. Additionally, it offers novel aspects at the advanced level. From the contents: Approximation and Polya Algorithms in Orlicz Spaces, Convex Sets and Convex Functions, Numerical Treatment of Nonlinear Equations and Optimization Problems, Stability and Two-stage Optimization Problems, Orlicz Spaces, Orlicz Norm and Duality, Differentiability and Convexity in Orlicz Spaces, Variational Calculus.

*Convex Optimization in Normed Spaces* Juan Peypouquet, 2015-03-18. This work is intended to serve as a guide for graduate students and researchers who wish to get acquainted with the main theoretical and practical tools for the numerical minimization of convex functions on Hilbert spaces. Therefore, it contains the main tools that are necessary to conduct independent research on the topic. It is also a concise, easy to follow, and self-contained textbook which may be useful for any researcher working on related fields as well as teachers giving graduate level courses on the topic. It will contain a thorough revision of the extant literature including both classical and state-of-the-art references.

**Optimization in Banach Spaces** Alexander J. Zaslavski, 2022-09-29. The book is devoted to the study of constrained minimization problems on closed and convex sets in Banach spaces with a Frechet differentiable objective function. Such problems are well studied in a finite dimensional space and in an infinite dimensional Hilbert space. When the space is Hilbert, there are many algorithms for solving optimization problems including the gradient projection algorithm, which is one of the most important tools in the optimization theory, nonlinear analysis, and their applications. An optimization problem is described by an objective function and a set of feasible points. For the gradient projection algorithm, each iteration consists of two steps. The first step is a calculation of a gradient of the objective function, while in the second one we calculate a projection on the feasible set. In each of these two steps, there is a computational error. In our recent research, we show that the gradient projection algorithm generates a good approximate solution if all the computational errors are bounded from above by a small positive constant. It should be mentioned that the properties of a Hilbert space play an important role. When we consider an optimization problem in a general Banach space, the situation becomes more difficult and less understood. On the other hand, such problems arise in the approximation theory. The book is of interest for mathematicians working in optimization. It also can be useful in preparation courses for graduate students. The main feature of the book, which appeals specifically to this audience, is the

study of algorithms for convex and nonconvex minimization problems in a general Banach space The book is of interest for experts in applications of optimization to the approximation theory In this book the goal is to obtain a good approximate solution of the constrained optimization problem in a general Banach space under the presence of computational errors It is shown that the algorithm generates a good approximate solution if the sequence of computational errors is bounded from above by a small constant The book consists of four chapters In the first we discuss several algorithms which are studied in the book and prove a convergence result for an unconstrained problem which is a prototype of our results for the constrained problem In Chapter 2 we analyze convex optimization problems Nonconvex optimization problems are studied in Chapter 3 In Chapter 4 we study continuous algorithms for minimization problems under the presence of computational errors The algorithm generates a good approximate solution if the sequence of computational errors is bounded from above by a small constant The book consists of four chapters In the first we discuss several algorithms which are studied in the book and prove a convergence result for an unconstrained problem which is a prototype of our results for the constrained problem In Chapter 2 we analyze convex optimization problems Nonconvex optimization problems are studied in Chapter 3 In Chapter 4 we study continuous algorithms for minimization problems under the presence of computational errors

*Unilateral Variational Analysis In Banach Spaces (In 2 Parts)* Lionel Thibault, 2023-02-14 The monograph provides a detailed and comprehensive presentation of the rich and beautiful theory of unilateral variational analysis in infinite dimensions It is divided into two volumes named Part I and Part II Starting with the convergence of sets and the semilimits and semicontinuities of multimappings the first volume develops the theories of tangent cones of subdifferentials of convexity and duality in locally convex spaces of extended mean value inequalities in absence of differentiability of metric regularity of constrained optimization problems The second volume is devoted to special classes of non smooth functions and sets It expands the theory of subsmooth functions and sets of semiconvex functions and multimappings of primal lower regular functions of singularities of non smooth mappings of prox regular functions and sets in general spaces of differentiability of projection mapping and others for prox regular sets Both volumes I and II contain for each chapter extensive comments covering related developments and historical comments Connected area fields of the material are optimization optimal control variational inequalities differential inclusions mechanics economics The book is intended for PhD students researchers and practitioners using unilateral variational analysis tools

**Optimization in Banach Spaces** Aleksandr J. Zaslavskij, 2022

[Convex Analysis and Optimization in Hadamard Spaces](#) Miroslav Bacak, 2014-10-29 In the past two decades convex analysis and optimization have been developed in Hadamard spaces This book represents a first attempt to give a systematic account on the subject Hadamard spaces are complete geodesic spaces of nonpositive curvature They include Hilbert spaces Hadamard manifolds Euclidean buildings and many other important spaces While the role of Hadamard spaces in geometry and geometric group theory has been studied for a long time first analytical results appeared

as late as in the 1990s Remarkably it turns out that Hadamard spaces are appropriate for the theory of convex sets and convex functions outside of linear spaces Since convexity underpins a large number of results in the geometry of Hadamard spaces we believe that its systematic study is of substantial interest Optimization methods then address various computational issues and provide us with approximation algorithms which may be useful in sciences and engineering We present a detailed description of such an application to computational phylogenetics The book is primarily aimed at both graduate students and researchers in analysis and optimization but it is accessible to advanced undergraduate students as well

Convex Functions, Monotone Operators and Differentiability Robert R. Phelps, 2013-12-11 These notes start with an introduction to the differentiability of convex functions on Banach spaces leading to the study of Asplund spaces and their intriguing relationship to monotone operators and more general set valued maps and Banach spaces with the Radon Nikodym property While much of this is classical some of it is presented using streamlined proofs which were not available until recently Considerable attention is paid to contemporary results on variational principles and perturbed optimization in Banach spaces exhibiting their close connections with Asplund spaces An introductory course in functional analysis is adequate background for reading these notes which can serve as the basis for a seminar of a one term graduate course There are numerous exercises many of which form an integral part of the exposition

*Convexity from the Geometric Point of View* Vitor Balestro, Horst Martini, Ralph Teixeira, 2024-07-14 This text gives a comprehensive introduction to the common core of convex geometry Basic concepts and tools which are present in all branches of that field are presented with a highly didactic approach Mainly directed to graduate and advanced undergraduates the book is self contained in such a way that it can be read by anyone who has standard undergraduate knowledge of analysis and of linear algebra Additionally it can be used as a single reference for a complete introduction to convex geometry and the content coverage is sufficiently broad that the reader may gain a glimpse of the entire breadth of the field and various subfields The book is suitable as a primary text for courses in convex geometry and also in discrete geometry including polytopes It is also appropriate for survey type courses in Banach space theory convex analysis differential geometry and applications of measure theory Solutions to all exercises are available to instructors who adopt the text for coursework Most chapters use the same structure with the first part presenting theory and the next containing a healthy range of exercises Some of the exercises may even be considered as short introductions to ideas which are not covered in the theory portion Each chapter has a notes section offering a rich narrative to accompany the theory illuminating the development of ideas and providing overviews to the literature concerning the covered topics In most cases these notes bring the reader to the research front The text includes many figures that illustrate concepts and some parts of the proofs enabling the reader to have a better understanding of the geometric meaning of the ideas An appendix containing basic and geometric measure theory collects useful information for convex geometers

*Convexity and Its Applications* GRUBER, WILLS, 2013-11-11 This collection of surveys consists in part

of extensions of papers presented at the conferences on convexity at the Technische Universitat Wien July 1981 and at the Universitat Siegen July 1982 and in part of articles written at the invitation of the editors This volume together with the earlier volume Contributions to Geometry edited by Tolke and Wills and published by Birkhauser in 1979 should give a fairly good account of many of the more important facets of convexity and its applications Besides being an up to date reference work this volume can be used as an advanced treatise on convexity and related fields We sincerely hope that it will inspire future research Fenchel in his paper gives an historical account of convexity showing many important but not so well known facets The articles of Papini and Phelps relate convexity to problems of functional analysis on nearest points nonexpansive maps and the extremal structure of convex sets A bridge to mathematical physics in the sense of Polya and Szego is provided by the survey of Bandle on isoperimetric inequalities and Bachem's paper illustrates the importance of convexity for optimization The contribution of Coxeter deals with a classical topic in geometry the lines on the cubic surface whereas Leichtweiss shows the close connections between convexity and differential geometry The exhaustive survey of Chalk on point lattices is related to algebraic number theory A topic important for applications in biology geology etc

### **Variational Analysis and Applications**

Franco Giannessi, Antonino Maugeri, 2007-03-06 This Volume contains the refereed papers presented at the 38th Conference of the School of Mathematics G Stampacchia of the E Majorana Centre for Scientific Culture of Erice Sicily held in Memory of G Stampacchia and J L Lions in the period June 20 July 2003 The presence of participants from Countries has greatly contributed to the success of the meeting The School of Mathematics was dedicated to Stampacchia not only for his great mathematical achievements but also because He founded it The core of the Conference has been the various features of the Variational Analysis and their motivations and applications to concrete problems Variational Analysis encompasses a large area of modern Mathematics such as the classical Calculus of Variations the theories of perturbation approximation subgradient subderivates set convergence and Variational Inequalities and all these topics have been deeply and intensely dealt during the Conference In particular Variational Inequalities which have been initiated by Stampacchia inspired by Signorini Problem and the related work of G Fichera have offered a very great possibility of applications to several fundamental problems of Mathematical Physics Engineering Statistics and Economics The pioneer work of Stampacchia and Lions can be considered as the basic kernel around which Variational Analysis is going to be outlined and constructed The Conference has dealt with both finite and infinite dimensional analysis showing that to carry on these two aspects disjointly is unsuitable for both

### **Duality for Nonconvex Approximation and Optimization**

Ivan Singer, 2007-03-12 The theory of convex optimization has been constantly developing over the past 30 years Most recently many researchers have been studying more complicated classes of problems that still can be studied by means of convex analysis so called anticonvex and convex anticonvex optimization problems This manuscript contains an exhaustive presentation of the duality for these classes of problems and some of its generalization in the framework of abstract

convexity This manuscript will be of great interest for experts in this and related fields

**Open Problems in the Geometry and Analysis of Banach Spaces** Antonio J. Guirao, Vicente Montesinos, Václav Zizler, 2016-07-26 This is an collection of some easily formulated problems that remain open in the study of the geometry and analysis of Banach spaces Assuming the reader has a working familiarity with the basic results of Banach space theory the authors focus on concepts of basic linear geometry convexity approximation optimization differentiability renormings weak compact generating Schauder bases and biorthogonal systems fixed points topology and nonlinear geometry The main purpose of this work is to help in convincing young researchers in Functional Analysis that the theory of Banach spaces is a fertile field of research full of interesting open problems Inside the Banach space area the text should help expose young researchers to the depth and breadth of the work that remains and to provide the perspective necessary to choose a direction for further study Some of the problems are longstanding open problems some are recent some are more important and some are only local problems Some would require new ideas some may be resolved with only a subtle combination of known facts Regardless of their origin or longevity each of these problems documents the need for further research in this area Journal of Nonlinear and Convex Analysis ,2007 Convex Analysis and Beyond Boris S. Mordukhovich, Nguyen Mau Nam, 2022-04-24 This book presents a unified theory of convex functions sets and set valued mappings in topological vector spaces with its specifications to locally convex Banach and finite dimensional settings These developments and expositions are based on the powerful geometric approach of variational analysis which resides on set extremality with its characterizations and specifications in the presence of convexity Using this approach the text consolidates the device of fundamental facts of generalized differential calculus to obtain novel results for convex sets functions and set valued mappings in finite and infinite dimensions It also explores topics beyond convexity using the fundamental machinery of convex analysis to develop nonconvex generalized differentiation and its applications The text utilizes an adaptable framework designed with researchers as well as multiple levels of students in mind It includes many exercises and figures suited to graduate classes in mathematical sciences that are also accessible to advanced students in economics engineering and other applications In addition it includes chapters on convex analysis and optimization in finite dimensional spaces that will be useful to upper undergraduate students whereas the work as a whole provides an ample resource to mathematicians and applied scientists particularly experts in convex and variational analysis optimization and their applications **SIAM Journal on Control and Optimization** Society for Industrial and Applied Mathematics, 2009



## Embracing the Track of Phrase: An Emotional Symphony within **Convexity And Optimization In Banach Spaces**

In some sort of used by displays and the ceaseless chatter of immediate conversation, the melodic elegance and psychological symphony produced by the published word frequently diminish into the backdrop, eclipsed by the relentless sound and disturbances that permeate our lives. But, nestled within the pages of **Convexity And Optimization In Banach Spaces** a wonderful fictional treasure brimming with raw thoughts, lies an immersive symphony waiting to be embraced. Crafted by a masterful musician of language, that charming masterpiece conducts readers on a mental trip, well unraveling the hidden tunes and profound affect resonating within each carefully constructed phrase. Within the depths of the moving review, we can investigate the book is central harmonies, analyze their enthralling writing style, and submit ourselves to the profound resonance that echoes in the depths of readers souls.

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