

# Advances in Mathematical Inequalities and Applications

Milica Klarinčić Bakula 

Faculty of Science, University of Split, Ruđera Boškovića 33, 21000 Split, Croatia; milica@pmfst.hr

## 1. Introduction

Why do we study inequalities? The answer to this question was given by Bellman in [1], in a very concrete and elegant fashion: “There are three reasons for the study of inequalities: practical, theoretical and aesthetic. In many practical investigations, it is necessary to bind one quantity to another. The classical inequalities are very useful for this purpose. From the theoretical point of view, very simple questions give rise to entire theories. For example, we may ask when the nonnegativity of one quantity implies that to another. This simple question leads to the theory of positive operators and theory of differential inequalities. Another question which gives rise to much interesting research is that of finding equalities associated with inequalities. We use the principle that every inequality should come from an equality which makes the inequality obvious. Along these lines, we may also look for representation which makes inequalities obvious. Often, these representations are the maxima or minima of certain quantities. Finally, let us turn to aesthetic aspects. As has been pointed out, beauty is in the eyes of the beholder. However, it is generally agreed that certain pieces of music, art or mathematics are beautiful. There is an elegance to inequalities that makes them very attractive”.

In this Special Issue, we present new results related to classical inequalities, such as the Jensen inequality, Jensen–Steffensen inequality, Jessen inequality, Grüss inequality, Chebyshev inequality, etc. They have various applications in various branches of mathematics, among which are numerical analysis, probability and statistics, as well as in other sciences, such as information theory.

## 2. Statistics of the Special Issue

A total of 30 papers were submitted for this Special Issue, of which 10 were published (33.33%) and 20 were rejected (66.67%), indicating a rigorous peer review process.

## 3. Overview of the Contributions to the Special Issue

1. Barotov, D.; Barotov, R.; Soloviev, V.; Feldin, V.; Muzafarov, D.; Engashboev, T.; Egamov, K. The Development of Suitable Inequalities and Their Application to Systems of Logical Equations. *Mathematics* **2022**, *10*(11), 1851; <https://doi.org/10.3390/math10111851>.

<https://www.mdpi.com/2227-7390/10/11/1851>

In this paper, two uncomplex inequalities are invented and intricately established, adequately describing the behaviour of discrete logical functions  $or(x_1, x_2, \dots, x_n)$  and  $and(x_1, x_2, \dots, x_n)$ . Based on these proven inequalities, infinitely differentiable extensions of the logical functions  $or(x_1, x_2, \dots, x_n)$  and  $and(x_1, x_2, \dots, x_n)$  were defined. These suitable extensions were applied to systems of logical equations. Specifically, the system of  $m$  logical equations is first transformed in  $R^n$  into an equivalent system of  $m$  smooth rational equations (**SmsRE**) in a constructive way, without adding any equations (field equations or otherwise), such that the solution of **SmsRE** can be reduced to the problem minimization of the objective function, and any numerical optimization methods can be applied, since the objective function will be infinitely differentiable. Transforming **SmsRE** into an equivalent system of  $m$  polynomial equations (**SmsPE**) means that any symbolic



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# Mathematical Inequalities

**Panos M Pardalos, Themistocles M  
Rassias**



## **Mathematical Inequalities:**

**Mathematical Inequalities** B. G. Pachpatte, 2005-05-04 The book addresses many important new developments in the field All the topics covered are of great interest to the readers because such inequalities have become a major tool in the analysis of various branches of mathematics It contains a variety of inequalities which find numerous applications in various branches of mathematics It contains many inequalities which have only recently appeared in the literature and cannot yet be found in other books It will be a valuable reference for someone requiring a result about inequalities for use in some applications in various other branches of mathematics Each chapter ends with some miscellaneous inequalities for further study The work will be of interest to researchers working both in pure and applied mathematics and it could also be used as the text for an advanced graduate course

**Mathematical Inequalities** Pietro Cerone, Silvestru Sever Dragomir, 2010-12-01 Drawing on the authors research work from the last ten years *Mathematical Inequalities A Perspective* gives readers a different viewpoint of the field It discusses the importance of various mathematical inequalities in contemporary mathematics and how these inequalities are used in different applications such as scientific modeling The authors *Advances in Mathematical Inequalities and Applications* Praveen Agarwal, Silvestru Sever Dragomir, Mohamed Jleli, Bessem Samet, 2018-12-31 This book is a collection of original research and survey articles on mathematical inequalities and their numerous applications in diverse areas of mathematics and engineering It includes chapters on convexity and related concepts inequalities for mean values sums functions operators functionals integrals and their applications in various branches of mathematics and related sciences fractional integral inequalities and weighted type integral inequalities It also presents their wide applications in biomathematics boundary value problems mechanics queuing models scattering and geomechanics in a concise but easily understandable way that makes the further ramifications and future directions clear The broad scope and high quality of the contributions make this book highly attractive for graduates postgraduates and researchers All the contributing authors are leading international academics scientists researchers and scholars

**Advances in Mathematical Inequalities** Shigeru Furuichi, 2020-01-20 Mathematical inequalities are essential tools in mathematics natural science and engineering This book gives an overview on recent advances Some generalizations and improvements for the classical and well known inequalities are described They will be applied and further developed in many fields Applications of the inequalities to entropy theory and quantum physics are also included *A Dictionary of Inequalities* Peter Bullen, 1998-08-21 The literature on inequalities is vast in recent years the number of papers as well as the number of journals devoted to the subject have increased dramatically At best locating a particular inequality within the literature can be a cumbersome task *A Dictionary of Inequalities* ends the dilemma of where to turn to find a result a related inequality or the references to the information you need It provides a concise alphabetical listing of each inequality by its common name or its subject with a short statement of the result some comments references to related inequalities and a list

of sources for further information The author uses only the most elementary of mathematical terminology and does not offer proofs thus making an interest in inequalities the only prerequisite for using the text The author focuses on intuitive physical forms of inequalities rather than their most general versions and retains the beauty and importance of original versions rather than listing their later abstract forms He presents each in its simplest form with other renditions such as for complex numbers and vectors as extensions or under different headings He has kept the book to a more manageable size by omitting inequalities in areas such as elementary geometric and trigonometric inequalities rarely used outside their fields The end result is a current concise reference that puts the essential results on inequalities within easy reach A Dictionary of Inequalities carries the beauty and attraction of the best and most successful dictionaries on looking up a given item the reader is likely to be intrigued and led by interest to others *Discrete Hilbert-Type Inequalities* Bicheng Yang, 2011 Discrete Hilbert type inequalities including Hilbert's inequality are important in mathematical analysis and its applications In 1998 the author presented an extension of Hilbert's integral inequality with an independent parameter In 2004 some new extensions of Hilbert's inequality were presented by introducing two pairs of conjugate exponents and additional independent parameters Since then a number of new discrete Hilbert type inequalities have arisen In this book the author explains how to use the way of weight coefficients and introduce specific parameters to build new discrete Hil

**Inequalities** G. H. Hardy, J. E. Littlewood, George Pólya, 1952 This classic of the mathematical literature forms a comprehensive study of the inequalities used throughout mathematics First published in 1934 it presents clearly and lucidly both the statement and proof of all the standard inequalities of analysis The authors were well known for their powers of exposition and made this subject accessible to a wide audience of mathematicians *Equations and Inequalities* Jiri Herman, Radan Kucera, Jaromir Simsa, 2012-12-06 This book is intended as a text for a problem solving course at the first or second year university level as a text for enrichment classes for talented high school students or for mathematics competition training It can also be used as a source of supplementary material for any course dealing with algebraic equations or inequalities or to supplement a standard elementary number theory course There are already many excellent books on the market that can be used for a problem solving course However some are merely collections of problems from a variety of fields and lack cohesion Others present problems according to topic but provide little or no theoretical background Most problem books have a limited number of rather challenging problems While these problems tend to be quite beautiful they can appear forbidding and discouraging to a beginning student even with well motivated and carefully written solutions As a consequence students may decide that problem solving is only for the few high performers in their class and abandon this important part of their mathematical and indeed overall education **Dictionary of Inequalities** Peter Bullen, 2015-06-15 Adding new results that have appeared in the last 15 years Dictionary of Inequalities Second Edition provides an easy way for researchers to locate an inequality by name or subject This edition offers an up to date alphabetical listing of each inequality

with a short statement of the result some comments references to related inequalities and

**When Less is More** Claudio Alsina, Roger B. Nelsen, 2009-12-31 Introduces the richness and variety of inequalities in mathematics using illustration and visualisation

*Hilbert-Type Integral Inequalities* Bicheng Yang, 2010-04-02 Hilbert type integral inequalities including the well known Hilbert's integral inequality published in 1908 are important in analysis and its applications This well organized handbook covers the newest methods of weight functions and most important results

**Half-Discrete Hilbert-Type Inequalities** Bicheng Yang, Lokenath Debnath, World Scientific (Firm), 2013-12-24 In 1934 G H Hardy et al published a book entitled *Inequalities* in which a few theorems about Hilbert type inequalities with homogeneous kernels of degree one were considered Since then the theory of Hilbert type discrete and integral inequalities is almost built by Prof Bicheng Yang in their four published books This monograph deals with half discrete Hilbert type inequalities By means of building the theory of discrete and integral Hilbert type inequalities and applying the technique of Real Analysis and Summation Theory some kinds of half discrete Hilbert type inequalities with the general homogeneous kernels and non homogeneous kernels are built The relating best possible constant factors are all obtained and proved The equivalent forms operator expressions and some kinds of reverses with the best constant factors are given We also consider some multi dimensional extensions and two kinds of multiple inequalities with parameters and variables which are some extensions of the two dimensional cases As applications a large number of examples with particular kernels are also discussed The authors have been successful in applying Hilbert type discrete and integral inequalities to the topic of half discrete inequalities The lemmas and theorems in this book provide an extensive account of these kinds of inequalities and operators This book can help many readers make good progress in research on Hilbert type inequalities and their applications

Contents Recent Developments of Hilbert Type Inequalities with Applications Improvements of the Euler Maclaurin Summation Formula and Applications A Half Discrete Hilbert Type Inequality with a General Homogeneous Kernel A Half Discrete Hilbert Type Inequality with a Non Homogeneous Kernel Multi dimensional Half Discrete Hilbert Type Inequalities Multiple Half Discrete Hilbert Type Inequalities Readership Graduate students and professional researchers in mathematics

Lyapunov-type Inequalities Juan Pablo Pinasco, 2013-09-14 The eigenvalue problems for quasilinear and nonlinear operators present many differences with the linear case and a Lyapunov inequality for quasilinear resonant systems showed the existence of eigenvalue asymptotics driven by the coupling of the equations instead of the order of the equations For  $p \geq 2$  the coupling and the order of the equations are the same so this cannot happen in linear problems Another striking difference between linear and quasilinear second order differential operators is the existence of Lyapunov type inequalities in  $\mathbb{R}^n$  when  $p > n$  Since the linear case corresponds to  $p = 2$  for the usual Laplacian there exists a Lyapunov inequality only for one dimensional problems For linear higher order problems several Lyapunov type inequalities were found by Egorov and Kondratiev and collected in *On spectral theory of elliptic operators* Birkhauser Basel 1996 However there exists an interesting interplay between the dimension of

the underlying space the order of the differential operator the Sobolev space where the operator is defined and the norm of the weight appearing in the inequality which is not fully developed Also the Lyapunov inequality for differential equations in Orlicz spaces can be used to develop an oscillation theory bypassing the classical Sturmian theory which is not known yet for those equations For more general operators like the  $p \times$  Laplacian the possibility of existence of Lyapunov type inequalities remains unexplored

**Advanced Inequalities** George A. Anastassiou, 2011 This monograph presents univariate and multivariate classical analyses of advanced inequalities This treatise is a culmination of the author's last thirteen years of research work The chapters are self contained and several advanced courses can be taught out of this book Extensive background and motivations are given in each chapter with a comprehensive list of references given at the end The topics covered are wide ranging and diverse Recent advances on Ostrowski type inequalities Opial type inequalities Poincaré and Sobolev type inequalities and Hardy-Opial type inequalities are examined Works on ordinary and distributional Taylor formulae with estimates for their remainders and applications as well as Chebyshev-Grüss Grüss and Comparison of Means inequalities are studied The results presented are mostly optimal that is the inequalities are sharp and attained Applications in many areas of pure and applied mathematics such as mathematical analysis probability ordinary and partial differential equations numerical analysis information theory etc are explored in detail as such this monograph is suitable for researchers and graduate students It will be a useful teaching material at seminars as well as an invaluable reference source in all science libraries

**Trace Inequalities** Airat M. Bikchentaev, Fuad Kittaneh, Mohammad Sal Moslehian, Yuki Seo, 2024-12-18 This book is a comprehensive and advanced exploration of trace inequalities in the context of matrices and operators acting on Hilbert spaces Its goal is to present elegant inequalities with innovative proofs Instead of presenting generalized versions that can be complicated and lack clarity the book focuses on beautiful and original inequalities Divided into eight chapters this book is designed for researchers and graduate students in mathematics physics and engineering It provides detailed explanations for most of the results and includes a variety of exercises and problems to help readers understand the content and inspire further research into advanced topics

**Risk and Uncertainty Reduction by Using Algebraic Inequalities** Michael T. Todinov, 2020-06-02 This book covers the application of algebraic inequalities for reliability improvement and for uncertainty and risk reduction It equips readers with powerful domain independent methods for reducing risk based on algebraic inequalities and demonstrates the significant benefits derived from the application for risk and uncertainty reduction Algebraic inequalities Provide a powerful reliability improvement risk and uncertainty reduction method that transcends engineering and can be applied in various domains of human activity Present an effective tool for dealing with deep uncertainty related to key reliability critical parameters of systems and processes Permit meaningful interpretations which link abstract inequalities with the real world Offer a tool for determining tight bounds for the variation of risk critical parameters and complying the design with these bounds to avoid failure Allow optimising designs and processes by

minimising the deviation of critical output parameters from their specified values and maximising their performance This book is primarily for engineering professionals and academic researchers in virtually all existing engineering disciplines

**Mathematical Analysis, Optimization, Approximation And Applications** Panos M Pardalos, Themistocles M Rassias, 2025-01-17 The comprehensive volume focuses on both research and survey papers presenting results in a broad spectrum of subjects in pure and applied mathematics such as in approximation theory optimization and their applications Topics within this book include Sobolev spaces Banach spaces locally convex spaces integral operators Szasz Mirakyan operators to name a few This useful reference text benefits professionals academics graduate students and advanced research scientists in theoretical computer science computer mathematics and general applied mathematics Effort was also made for the content to constitute a reference source for researchers in physics and engineering

Differential and Integral Inequalities Dorin Andrica, Themistocles M. Rassias, 2019-11-14 Theories methods and problems in approximation theory and analytic inequalities with a focus on differential and integral inequalities are analyzed in this book Fundamental and recent developments are presented on the inequalities of Abel Agarwal Beckenbach Bessel Cauchy Hadamard Chebychev Markov Euler's constant Grothendieck Hilbert Hardy Carleman Landau Kolmogorov Carlson Bernstein Mordell Gronwall Wirtinger as well as inequalities of functions with their integrals and derivatives Each inequality is discussed with proven results examples and various applications Graduate students and advanced research scientists in mathematical analysis will find this reference essential to their understanding of differential and integral inequalities Engineers economists and physicists will find the highly applicable inequalities practical and useful to their research

**Some Extended Applications of Hardy-Hilbert's Integral Inequality** Bicheng Yang, 2025-05-13 In this book by applying the weight functions the idea of introduced parameters and the techniques of real analysis and functional analysis we use some lemmas and then provide a new Hilbert type integral inequality with the nonhomogeneous kernel and the best possible constant factor As applications some new Hardy Hilbert's integral inequalities with two interval variables involving extended derivative functions of higher order and extended multiple upper limit functions are obtained The equivalent statements of the best possible constant factors related to several parameters are given

**Probabilistic Inequalities** George A Anastassiou, 2009-08-11 In this monograph the author presents univariate and multivariate probabilistic inequalities with coverage on basic probabilistic entities like expectation variance moment generating function and covariance These are built on the recent classical form of real analysis inequalities which are also discussed in full details This treatise is the culmination and crystallization of the author's last two decades of research work in related discipline Each of the chapters is self contained and a few advanced courses can be taught out of this book Extensive background and motivations for specific topics are given in each chapter A very extensive list of references is also provided at the end The topics covered in this unique book are wide ranging and diverse The opening chapters examine the probabilistic Ostrowski type inequalities and various related ones as well as the largely discusses about

the Grothendieck type probabilistic inequalities The book is also about inequalities in information theory and the Csiszar's f Divergence between probability measures A great section of the book is also devoted to the applications in various directions of Geometry Moment Theory Also the development of the Gr ss type and Chebyshev Gr ss type inequalities for Stieltjes integrals and the applications in probability are explored in detail The final chapters discuss the important real analysis methods with potential applications to stochastics The book will be of interest to researchers and graduate students and it is also seen as an invaluable reference book to be acquired by all science libraries as well as seminars that conduct discussions on related topics



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