Introduction To Linear Optimization

Introduction To Linear Optimization Introduction to Linear Optimization Linear optimization, also known as linear programming, is a fundamental mathematical method used for decision-making in various fields such as business, engineering, economics, and logistics. It involves optimizing a linear objective function subject to a set of linear constraints. This technique helps organizations and individuals determine the most efficient way to allocate limited resources to achieve a desired goal, such as maximizing profit or minimizing costs. Understanding the basics of linear optimization is essential for those involved in operations research, data analysis, and strategic planning. What Is Linear Optimization? Linear optimization is a mathematical approach to find the best possible outcome in a given problem with linear relationships. It models real-world scenarios where resources are constrained and decisions need to be optimized. Key Components of Linear Optimization Decision Variables: The variables that represent choices to be made (e.g., number of products to produce). Objective Function: A linear function representing the goal, such as maximizing profit or minimizing cost. Constraints: A set of linear inequalities or equations that define the limitations or requirements of the problem (e.g., resource limits). Historical Background and Importance Linear optimization has a rich history dating back to the 1940s, with significant contributions from mathematicians like George Dantzig, who developed the simplex method. This technique revolutionized operational research, enabling efficient solutions to complex problems involving multiple variables and constraints. The importance of linear optimization stems from its wide applicability: Supply chain management Production scheduling Financial portfolio optimization Transportation and logistics Resource allocation in various industries 2 Formulating a Linear Optimization Problem To solve a linear optimization problem, it must be properly formulated. The process involves defining decision variables, constructing the objective function, and establishing constraints. Step-by-Step Formulation Identify Decision Variables: Determine what choices need to be made. For1. example, how many units of each product to produce. Define the Objective Function: Express the goal mathematically,

such as2. maximizing revenue or minimizing costs, as a linear function of the decision variables. Set the Constraints: List all limitations and requirements as linear inequalities or3. equations, such as resource limits, demand requirements, and capacity constraints. Ensure Feasibility: Check that the problem has at least one feasible solution that4. satisfies all constraints. Mathematical Representation A typical linear optimization problem can be written as: Maximize (or Minimize) Z = c x + c x + ... + c x Subject to: a x + a x + ... + a x b a x + a x + ... + a x b ... a_m x + a_m x + ... + a_m x b_m x , x , ..., x 0 Where: c , c , ..., c are coefficients in the objective function. a , a , ..., a_m are coefficients in the constraints. b , b , ..., b_m are limits or capacities. x , x , ..., x are decision variables. Methods for Solving Linear Optimization Problems Several algorithms and methods have been developed to solve linear programming problems efficiently. 3 Simplex Method Developed by George Dantzig in 1947. Iteratively moves along the edges of the feasible region to find the optimal solution. Most widely used method for solving large-scale linear programming problems. Interior-Point Methods Alternative to the simplex method, especially for very large problems. Works within the feasible region rather than along its edges. Graphical Method Suitable for problems with two variables. Visualizes the feasible region and identifies the optimal point graphically. Applications of Linear Optimization Linear optimization is a versatile tool used across many industries and disciplines. Supply Chain and Logistics Optimizing transportation routes to minimize costs. Inventory management and stock allocation. Manufacturing and Production Determining the optimal mix of products to maximize profit. Scheduling machines and labor to meet demand efficiently. Finance Portfolio optimization to maximize return for a given risk level. Risk management and capital budgeting. Energy and Environment Allocating resources for renewable energy projects. Reducing emissions through optimal operational decisions. Challenges and Limitations While linear optimization is powerful, it has some limitations: Linearity Assumption: Assumes relationships are linear, which may not always 4 reflect real-world complexities. Deterministic Nature: Presumes all parameters are known with certainty, ignoring uncertainties. Scalability: Extremely large problems may require significant computational resources. To address these issues, extensions such as nonlinear programming, stochastic programming, and robust optimization have been developed. Future Trends in Linear Optimization The field continues to evolve with advancements in computational power and algorithms: Integration with artificial intelligence and machine learning for better data-driven modeling.

Development of hybrid methods combining linear programming with other optimization techniques. Application in emerging fields like smart grids, autonomous systems, and big data analytics. Conclusion Understanding the fundamentals of linear optimization is crucial for effective decision- making in resource-constrained environments. Its mathematical foundation provides a structured approach to solving complex problems efficiently. Whether in manufacturing, finance, logistics, or energy, linear programming offers a powerful tool to optimize outcomes and improve operational efficiency. As technology advances, the scope and capabilities of linear optimization will continue to expand, making it an essential component of modern analytical and strategic processes. QuestionAnswer What is linear optimization and how is it used in decision-making? Linear optimization, also known as linear programming, is a mathematical method used to find the best possible outcome (such as maximum profit or minimum cost) in a model with linear relationships. It is widely used in decision-making processes across industries like logistics, finance, and manufacturing to optimize resource allocation. What are the key components of a linear optimization problem? The key components include an objective function to be maximized or minimized, decision variables that represent choices, and a set of linear constraints that define the feasible solution space. 5 How do you formulate a linear optimization problem? Formulating a linear optimization problem involves defining decision variables, establishing the objective function as a linear combination of these variables, and setting up linear constraints that the decision variables must satisfy. What are common methods used to solve linear optimization problems? Common methods include the Simplex method, which efficiently searches for the optimal solution, and interior- point methods, which are useful for large-scale problems. Software tools like Excel Solver and specialized optimization packages are also widely used. What are the assumptions underlying linear optimization? Linear optimization assumes linearity of the objective function and constraints, divisibility of decision variables, certainty of data, and that there are no interactions among decision variables beyond linear relationships. Can linear optimization handle multiple objectives? Traditional linear optimization handles a single objective, but multi-objective linear programming techniques exist to optimize multiple conflicting goals simultaneously, often through methods like goal programming or weighted sums. What are some real-world applications of linear optimization? Real-world applications include supply chain management, production scheduling, transportation problems, portfolio optimization in finance, and resource allocation in healthcare and energy sectors. Introduction to Linear Optimization: Unlocking the Power of

Mathematical Decision-Making In the world of operations research, data analysis, and decision science, linear optimization—also known as linear programming—serves as a fundamental tool for solving complex problems involving resource allocation, production planning, transportation, and more. Its ability to find the most efficient solution within a set of constraints makes it invaluable across industries, from manufacturing to finance, logistics to healthcare. Understanding the core principles of linear optimization provides a solid foundation for tackling real-world problems where optimal decisions are crucial. --- What is Linear Optimization? At its core, linear optimization involves maximizing or minimizing a linear objective function subject to a set of linear constraints. These constraints represent limitations or requirements that the decision variables must satisfy, such as budget caps, resource availability, or minimum production levels. The Basic Components - Decision Variables: The variables that represent the choices to be made (e.g., how many units of products to produce). - Objective Function: A linear expression representing the goal—such as profit maximization or cost minimization. - Constraints: Equations or inequalities that restrict the decision variables based on real-world limitations. Mathematical Formulation A typical linear optimization problem takes the form: Maximize or Minimize: $$Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$$ Subject to: $$a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n \leq b_1$$ $$a_{21}x_1 + a_{22}x_2 + \dots +$$ Introduction To Linear Optimization 6 $$a_{2n}x_n \leq b_2$$ $$\dots$$ $$a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n \leq b_m$$ $$x_1, x_2, \dots, x_n \geq 0$$ where: - c_j are coefficients in the objective function, - a_{ij} are coefficients in the constraints, - b_i are the right-hand sides of the constraints, - x_j are the decision variables. --- Historical Background and Significance Linear optimization emerged during World War II as a method for military logistics and resource management. Its development is credited to mathematicians like George Dantzig, who formulated the simplex algorithm—the most widely used method for solving linear programming problems. Today, linear optimization is foundational in fields such as: - Supply chain management - Portfolio optimization - Production scheduling - Network flows - Energy management Its significance lies in its ability to provide clear, optimal solutions efficiently, even for large-scale problems. --- How Linear Optimization Works: The Geometric Perspective Understanding linear optimization intuitively can be enhanced through geometric visualization. Feasible Region All the points $(x_1, x_2, \dots, x_n)$ that satisfy the constraints form a convex polyhedron called the feasible region. Since the constraints are linear, this region is a convex shape in n-dimensional

space. Objective Function as a Plane The objective function defines a family of parallel hyperplanes (in 3D, planes). The optimal solution occurs at a vertex (corner point) of the feasible region where the objective function's hyperplane just "touches" the feasible region. Optimization Process - Moving the hyperplane in the direction of increasing (or decreasing) the objective function. - The last point of contact with the feasible region before it leaves the region is the optimal solution. This geometric insight underpins the simplex method, which systematically examines vertices of the feasible region to find the optimum. --- Methods for Solving Linear Optimization Problems While the geometric interpretation provides intuition, practical solutions often require algorithmic methods: 1. Simplex Method - Developed by George Dantzig in 1947. - Iteratively moves along the edges of the feasible region to find the optimal vertex. - Efficient for large problems, especially with sparse data. 2. Interior-Point Methods - Approximate the solution by traversing the interior of the feasible region. - Often faster for very large problems. - Suitable for modern large-scale optimization software. 3. Cutting Plane Methods - Used when dealing with integer or combinatorial constraints. - Iteratively refines the feasible region by adding hyperplanes (cuts). --- Practical Applications of Linear Optimization Linear optimization is widely used across various sectors: Manufacturing and Production - Determining the optimal mix of products to maximize profit. - Minimizing costs while meeting demand and resource constraints. Supply Chain and Logistics - Optimizing transportation routes to minimize shipping costs. - Inventory management to balance holding costs and service levels. Finance and Investment - Portfolio optimization to maximize returns under risk constraints. - Asset allocation models. Energy and Utilities - Scheduling power generation to minimize costs. - Managing renewable energy resources efficiently. Healthcare - Allocating medical supplies and staff. - Scheduling surgeries and Introduction To Linear Optimization 7 patient treatments to optimize resource use. --- Key Considerations and Limitations While linear optimization is powerful, it has limitations: Assumption of Linearity - Both the objective function and constraints must be linear. - Many real-world problems involve nonlinear relationships, requiring advanced methods like nonlinear programming. Certainty of Data - Assumes known, deterministic data. - In practice, data may be uncertain, leading to stochastic or robust optimization models. Integer and Binary Constraints - Standard linear programming solutions assume continuous variables. - Problems requiring decision variables to be integers (e.g., yes/no decisions) are known as integer programming problems, which are more complex. --- Software and Tools for Linear Optimization Modern computational tools have made solving linear optimization

problems accessible: - Excel Solver: User-friendly for small-scale problems. - LINDO/LINGO: Specialized optimization software. - CPLEX and Gurobi: Powerful commercial solvers for large problems. - Open-source options: CBC, GLPK, and COIN-OR. These tools typically implement the simplex algorithm, interior-point methods, or a combination, enabling practitioners to model and solve complex problems efficiently. --- Conclusion: Why Linear Optimization Matters Linear optimization stands as a cornerstone of decision science, offering a systematic way to find the best possible solution given limited resources and multiple constraints. Its mathematical elegance, combined with computational efficiency, makes it a versatile tool across industries. Whether optimizing a manufacturing process, planning a delivery route, or managing a financial portfolio, understanding the principles behind linear optimization can empower professionals to make informed, data-driven decisions that maximize value and efficiency. By mastering the fundamentals of linear optimization, decision-makers can unlock new levels of operational excellence, strategic planning, and problem-solving—all essential in today's competitive, data-rich environment. linear programming, optimization techniques, mathematical modeling, constraints, objective function, feasible region, simplex method, convex optimization, duality, applications in operations research

Introduction To Linear OptimizationConical Approach to Linear ProgrammingIntroduction to Linear OptimizationLinear Optimization Problems with Inexact DataIntroduction to Linear Optimization and Extensions with MATLABLarge Scale Linear and Integer Optimization: A Unified ApproachOperations ResearchLinear OptimizationConical Approach to Linear ProgrammingLinear OptimizationOptimization for ProfitModeling and Solving Linear Programming with RLinear Optimization for BusinessIntroduction to Linear and Convex ProgrammingLinear Optimization in ApplicationsLinear Optimization and ApproximationLinear and Nonlinear ProgrammingLinear Optimization and ExtensionsLinear and Nonlinear OptimizationA Mathematical Primer on Linear Optimization Arkadi Nemirovski P D'Alessandro Dimitris Bertsimas Miroslav Fiedler Roy H. Kwon Richard Kipp Martin Charles M. Harvey W. Allen Spivey P D'Alessandro Glenn Hurlbert Filmore E. Bender Jose M. Sallan Marcos Singer Neil Cameron S.L. Tang K. Glashoff David G. Luenberger Manfred Padberg Igor Griva Diogo Gomes Introduction To Linear Optimization Conical Approach to Linear Programming Introduction to Linear Optimization Linear Optimization Problems with Inexact Data Introduction to Linear Optimization and Extensions with MATLAB Large Scale Linear

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the book presents a graduate level rigorous and self contained introduction to linear optimization lo the presented topics being

the conical approach provides a geometrical understanding of optimization and is a powerful research tool and useful problem solving technique for example in decision support and real time control applications conical optimality conditions are first stated in a very general optimization framework and then applied to linear programming a complete theory along with primal and dual algorithms is given and solutions and algorithms are also provided for vector and robust linear optimization the advantages of parameter dependence of conical methods are fully discussed in addition to numerical results the book provides source codes and detailed documentation of a modula 2 implementation for the main algorithms

linear programming attracted the interest of mathematicians during and after world war ii when the first computers were constructed and methods for solving large linear programming problems were sought in connection with specific practical problems for example providing logistical support for the u s armed forces or modeling national economies early attempts to apply linear programming methods to solve practical problems failed to satisfy expectations there were various reasons for the failure one of them which is the central topic of this book was the inexactness of the data used to create the models this phenomenon inherent in most pratical problems has been dealt with in several ways at first linear programming models used

average values of inherently vague coefficients but the optimal solutions of these models were not always optimal for the original problem itself later researchers developed the stochastic linear programming approach but this too has its limitations recently interest has been given to linear programming problems with data given as intervals convex sets and or fuzzy sets the individual results of these studies have been promising but the literature has not presented a unified theory linear optimization problems with inexact data attempts to present a comprehensive treatment of linear optimization with inexact data summarizing existing results and presenting new ones within a unifying framework

filling the need for an introductory book on linear programming that discusses the important ways to mitigate parameter uncertainty introduction to linear optimization and extensions with matlab provides a concrete and intuitive yet rigorous introduction to modern linear optimization in addition to fundamental topics the book discusses current l

in this book kipp martin has systematically provided users with a unified treatment of the algorithms and the implementation of the algorithms that are important in solving large problems parts i and ii of large scale linear and integer programming provide an introduction to linear optimization using two simple but unifying ideas projection and inverse projection the ideas of projection and inverse projection are also extended to integer linear optimization with the projection inverse projection approach theoretical results in integer linear optimization become much more analogous to their linear optimization counterparts hence with an understanding of these two concepts the reader is equipped to understand fundamental theorems in an intuitive way part iii presents the most important algorithms that are used in commercial software for solving real world problems part iv shows how to take advantage of the special structure in very large scale applications through decomposition part v describes how to take advantage of special structure by modifying and enhancing the algorithms developed in part iii this section contains a discussion of the current research in linear and integer linear programming the author also shows in part v how to take different problem formulations and appropriately modify them so that the algorithms from part iii are more efficient again the projection and inverse projection concepts are used in part v to present the current research in linear and integer linear optimization in a very unified way

linear optimization formulation of linear optimization models the simplex algorithm the simplex algorithm further topics further topics in linear optimization postoptimal analysis and duality theory transportation models and related types of models multiperiod models for production and inventory integer programming models decision analysis probability the quantification of uncertainty decision making under uncertainty value and utility the quantification of preferences statistical decision theory

the conical approach provides a geometrical understanding of optimization and is a powerful research tool and useful problem solving technique for example in decision support and real time control applications conical optimality conditions are first stated in a very general optimization framework and then applied to linear programming a complete theory along with primal and dual algorithms is given and solutions and algorithms are also provided for vector and robust linear optimization the advantages of parameter dependence of conical methods are fully discussed in addition to numerical results the book provides source codes and detailed documentation of a modula **2** implementation for the main algorithms

the subject a little explanation is in order for our choice of the title linear opti **1** mization and corresponding terminology for what has traditionally been called linear programming theword programming in this context can be confusing and or misleading to students linear programming problems are referred to as optimization problems but the general term linear p gramming remains this can cause people unfamiliar with the subject to think that it is about programming in the sense of writing computer code it isn t this workbook is about the beautiful mathematics underlying the ideas of optimizing linear functions subject to linear constraints and the algorithms to solve such problems in particular much of what we d cuss is the mathematics of simplex algorithm for solving such problems developed by george dantzig in the late **1940s** the word program in linear programming is a historical artifact when dantzig rstdevelopedthe simplex algorithm to solvewhat arenowcalled linear programming problems his initial model was a class of resource location problems to be solved for the u s air force the decisions about theallocationswerecalled programs bytheairforce andhencetheterm

this major new volume provides business decisionmakers and analysts with a tool that provides a logical structure for

understanding problems as well as a mathematical technique for solving them the primary tool presented throughout optimization for profit is linear programming lp a medium that can be mastered by any individual who seeks to improve his her analytical and decisionmaking skills one of the special features of optimization for profit is the illustration of activity analysis as the technique used to formulate problems by using activity analysis as the problem structure linear programming become a natural extension of the way decision makers approach problems as a result linear programming becomes an integral part of the thinking process of the individual consequently students or practitioners can readily create a linear programming model of an entire business or any part of a business several chapters are devoted to describing this technique and illustrating its application to many different types of companies including an oil refinery a marmalade production company and a chicken processing plant a thorough study of optimization for profit will enable you to work with any manufacturer or service industry and model all or part of the operation and then solve the model to determine how best to minimize costs or maximize profits many firms save hundreds of thousands of dollars each year through the application of linear programming the authors have presented the material in this vital book so clearly and thoroughly that an individual could master the material through self study the inclusion of problems at the end of each chapter makes this book suitable as a textbook at the advanced undergraduate or beginning graduate level at most colleges or universities for students of management science operations research personnel and applied mathematicians working in industry government or academia notable features of the book include the practical aspects of modeling a business or any part of a business using linear programming a unique approach to explain the simplex method for solving linear programming problems real life practical problems that are presented and solved in detail detailed instructions for those interested in solving linear programming problems on all types of computers from mainframes to pcs numerous problems provided for the benefit of the student and all of the linear programming models described in these problems as well as in the text itself are available on a diskette

linear programming is one of the most extensively used techniques in the toolbox of quantitative methods of optimization one of the reasons of the popularity of linear programming is that it allows to model a large variety of situations with a simple framework furthermore a linear program is relatively easy to solve the simplex method allows to solve most linear programs

efficiently and the karmarkar interior point method allows a more efficient solving of some kinds of linear programming the power of linear programming is greatly enhanced when came the opportunity of solving integer and mixed integer linear programming in these models all or some of the decision variables are integers respectively in this book we provide a brief introduction to linear programming together with a set of exercises that introduce some applications of linear programming we will also provide an introduction to solve linear programming in r for each problem a possible solution through linear programming is introduced together with the code to solve it in r and its numerical solution

this book takes a unique approach to linear optimization by focusing on the underlying principles and business applications of a topic more often taught from a mathematical and computational perspective by shifting the perspective away from heavy math students learn how optimization can be used to drive decision making in real world business settings the book does not shy away from the theory underlying linear optimization but rather focuses on ensuring students understand the logic without getting caught up in proving theorems plenty of examples applications and case studies are included to help bridge the gap between the theory and the way it plays out in practice the author has also included several excel spreadsheets showing worked out models of linear optimization that have been used to drive decisions ranging from configuring a police force to purchasing crude oil and media planning how can the routes and pricing structures of airlines be optimized how much should be invested in the prevention and punishment of crimes these are everyday problems that can be solved using linear optimization and this book shows students just how to do that it will prove a useful math free resource for all students of management science and operations research

this introduction to optimization emphasizes the need for both a pure and an applied mathematical point of view beginning with a chapter on linear algebra and euclidean geometry the author then applies this theory with an introduction to linear programming there follows a discussion of convex analysis which finds application in non linear programming the book ends with an extensive commentary to the exercises that are given at the end of each chapter the author s straightforward geometrical approach makes this an attractive textbook for undergraduate students of mathematics engineering operations

research and economics

this book aims to illustrate with practical examples the applications of linear optimization techniques it is written in simple and easy to understand language and has put together a useful and comprehensive set of worked examples based on real life problems the topics include linear programming integer programming and goal programming the book can be used by teachers taught course students and research students of engineering and business management disciplines it is however not suitable for students of pure mathematics as its emphasis is on applications rather than theories

a linear optimization problem is the task of minimizing a linear real valued function of finitely many variables subject to linear con straints in general there may be infinitely many constraints this book is devoted to such problems their mathematical properties are investi gated and algorithms for their computational solution are presented applications are discussed in detail linear optimization problems are encountered in many areas of appli cations they have therefore been subject to mathematical analysis for a long time we mention here only two classical topics from this area the so called uniform approximation of functions which was used as a mathematical tool by chebyshev in 1853 when he set out to design a crane and the theory of systems of linear inequalities which has already been studied by fourier in 1823 we will not treat the historical development of the theory of linear optimization in detail however we point out that the decisive break through occurred in the middle of this century it was urged on by the need to solve complicated decision problems where the optimal deployment of military and civilian resources had to be determined the availability of electronic computers also played an important role the principal computational scheme for the solution of linear optimization problems the simplex algorithm was established by dantzig about 1950 in addi tion the fundamental theorems on such problems were rapidly developed based on earlier published results on the properties of systems of linear inequalities

this new edition covers the central concepts of practical optimization techniques with an emphasis on methods that are both state of the art and popular one major insight is the connection between the purely analytical character of an optimization

problem and the behavior of algorithms used to solve a problem this was a major theme of the first edition of this book and the fourth edition expands and further illustrates this relationship as in the earlier editions the material in this fourth edition is organized into three separate parts part i is a self contained introduction to linear programming the presentation in this part is fairly conventional covering the main elements of the underlying theory of linear programming many of the most effective numerical algorithms and many of its important special applications part ii which is independent of part i covers the theory of unconstrained optimization including both derivations of the appropriate optimality conditions and an introduction to basic algorithms this part of the book explores the general properties of algorithms and defines various notions of convergence part iii extends the concepts developed in the second part to constrained optimization problems except for a few isolated sections this part is also independent of part i it is possible to go directly into parts ii and iii omitting part i and in fact the book has been used in this way in many universities new to this edition is a chapter devoted to conic linear programming a powerful generalization of linear programming indeed many conic structures are possible and useful in a variety of applications it must be recognized however that conic linear programming is an advanced topic requiring special study another important topic is an accelerated steepest descent method that exhibits superior convergence properties and for this reason has become quite popular the proof of the convergence property for both standard and accelerated steepest descent methods are presented in chapter 8 as in previous editions end of chapter exercises appear for all chapters from the reviews of the third edition this very well written book is a classic textbook in optimization it should be present in the bookcase of each student researcher and specialist from the host of disciplines from which practical optimization applications are drawn jean jacques strodiot zentralblatt math vol 1207 2011

from the reviews do you know m padberg s linear optimization and extensions now here is the continuation of it discussing the solutions of all its exercises and with detailed analysis of the applications mentioned tell your students about it for those who strive for good exercises and case studies for lp this is an excellent volume acta scientiarum mathematicarum

provides an introduction to the applications theory and algorithms of linear and nonlinear optimization the emphasis is on

practical aspects discussing modern algorithms as well as the influence of theory on the interpretation of solutions or on the design of software the book includes several examples of realistic optimization models that address important applications the succinct style of this second edition is punctuated with numerous real life examples and exercises and the authors include accessible explanations of topics that are not often mentioned in textbooks such as duality in nonlinear optimization primal dual methods for nonlinear optimization filter methods and applications such as support vector machines the book is designed to be flexible it has a modular structure and uses consistent notation and terminology throughout it can be used in many different ways in many different courses and at many different levels of sophistication

the book provides a self contained mathematical introduction to linear optimization for undergraduate students of mathematics this book is equally suitable for science engineering and economics students who are interested in gaining a deeper understanding of the mathematical aspects of the subject the linear optimization problem is analyzed from different perspectives topological algebraic geometrical logical and algorithmic nevertheless no previous knowledge of these subjects is required the essential details are always provided in a special section at the end of each chapter the technical material is illustrated with multiple examples problems with fully worked solutions and a range of proposed exercises in chapter 1 several formulations of the linear optimization problem are presented and related concerning admissible vectors and optimizers then sufficient conditions for the existence of optimizers based on topological techniques are discussed in chapter 2 the main objective of chapter 3 is to provide a way for deciding whether or not an admissible vector is an optimizer relying on farkas lemma in chapter 4 linear algebra is used for computing optimizers via basic admissible vectors a geometrical characterization of these vectors is the goal of chapter 5 duality is discussed in chapter 6 giving yet a new technique for finding optimizers an introduction to computational complexity is presented in chapter 7 with the aim to analyze the efficiency of linear optimization algorithms the complexity of a brute force algorithm is shown not to be polynomial chapter 8 is targeted at the simplex algorithm it includes the proof of its soundness and completeness and an explanation on its non polynomial complexity finally chapter 9 concentrates on the integer optimization problem with an emphasis on totally unimodularity an algorithm based on the branch and bound technique is analyzed

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Introduction

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