LINEAR PROGRAMMING IN INDUSTRY pdf

1: Linear programming in Construction Project Management

Linear programming (LP) is useful for resource optimization, as long as the constraints and the objective function are linear or can be linearized (also, it helps if feasible solutions exist and especially if optimal solutions exist, but uniquenes.

So our equations are as follows: I hope now you are available to make sense of the entire advertising problem. All the above equations, are only for your better understanding. On solving the objective function you will get the maximum weekly audience as 1,, You can follow the tutorial here to solve the equation. To solve linear program in excel, follow this tutorial. It is used to calculate the feasible solution for transporting commodities from one place to another. Whenever you are given a real-world problem, which involves supply and demand from one source of different source. The data model includes the following: The level of supply and demand at each source is given The unit transportation of a commodity from each source to each destination The model assumes that there is only one commodity. The demand for which can come from different sources. The objective is to fulfill the total demand with minimum transportation cost. The model is based on the hypothesis that the total demand is equal to the total supply, i. Consider there are 3 silos which are required to satisfy the demand from 4 mills. A silo is a storage area of farm used to store grain and Mill is a grinding factory for grains. The objective is to find the minimal transportation cost such that the demand for all the mills is satisfied. As the name suggests Northwest corner method is a method of allocating the units starting from the topleft cell. The demand for Mill 1 is 5 and Silo 1 has a total supply of The demand for Mill1 is met. Then we move onto Mill 3, the northwest cell is S2M3. This method derives more accurate result than Northwest corner method. It is used for transportation and manufacturing problems. According to the least cost method, you start from the cell containing the least unit cost for transportation. Well the above method explains we can optimize our costs further with the best method. Solver is an in-built add-on in Microsoft Excel. Your solver is now added in excel. You can check it under the Data tab. The first thing I am gonna do is enter my data in excel. After entering the data in excel, I have calculated the total of C3: This is done to take the total demand from Silo 1 and others. The first table gives me the units supplied and the second table gives me the unit cost. Now, I am calculating my total cost which will be given by Sumproduct of unit cost and units supplied. Now I am gonna use Solver to compute my model. Similar to the above method. Add the objective function, variable cells, constraints. Now your model is ready to be solved. Click on solve and you will get your optimal cost. Manufacturing and service industry uses linear programming on a regular basis. In this section, we are going to look at the various applications of Linear programming. Manufacturing industries use linear programming for analyzing their supply chain operations. Their motive is to maximize efficiency with minimum operation cost. As per the recommendations from the linear programming model, the manufacturer can reconfigure their storage layout, adjust their workforce and reduce the bottlenecks. Here is a small Warehouse case study of Cequent a US base company, watch this video for a more clear understanding. Linear programming is also used in organized retail for shelf space optimization. Since the number of products in the market have increased in leaps and bounds, it is important to understand what does the customer want. The products in the store are placed strategically keeping in mind the customer shopping pattern. This is with subject to constraints like limited shelf space, the variety of products, etc. Optimization is also used for optimizing Delivery Routes. This is an extension of the popular traveling salesman problem. With the help of clustering and greedy algorithm the delivery routes are decided by companies like FedEx, Amazon, etc. The objective is to minimize the operation cost and time. Optimizations is also used in Machine Learning. Supervised Learning works on the fundamental of linear programming. A system is trained to fit on a mathematical model of a function from the labeled input data that can predict values from an unknown test data. There are many more applications of linear programming in real-world like applied by Shareholders, Sports, Stock Markets, etc. Go on and explore further. End Notes I hope you enjoyed reading this article. I have tried to explain all the basic concepts under linear programming. If you have any doubts or questions feel free to post them in the comments section. I have explained each concept with real life example. I want you to try them at your end and get hands-on experience. Let me know what you think!

2: Five Areas of Application for Linear Programming Techniques | Sciencing

The present volume is intended to serve a twofold purpose. First, it provides a university text of Linear Programming for students of economics or operations research interested in the theory of production and cost and its practical applications; secondly, it is the author's hope that engineers.

Linear programming is extensively used to solve a variety of industrial problems. In each of these applications, the general objective is to determine a plan for production and procurement in the time period under consideration. It is necessary to satisfy all demand requirements without violating any of the constraints. An industrial concern has available to itself a certain productive capacity of its various manufacturing process and has the opportunity to utilize this capacity to manufacture various products. Generally different products will have different unit costs as well as selling prices and therefore will have different unit profits. The linear programming technique may often be used in situations where several products can with varying efficiency be made on each of several different machines the problem is to decide on a program which will maximize output minimize cost, or produce some other criterion of efficiency. For example if 20 jobs are to be arranged between 5 machines, there are a million of possible arrangements since the machines could be different in their performances. Thus a very large choice remains for the scheduling officer who can only consider a fraction of these as a result he may well overlook an unexpected optimum. A different kind of production scheduling problem arises where for instance a manufacturer has to meet fluctuating e. Here again there are many different schedules which could satisfy requirements, but the problem is to find the correct balance between the conflicting costs of output fluctuation and excessive inventories. Similarly linear programming is useful for allocating operators to machines products to machines clerks to particularly tasks and in providing optimal connection between production centers and wholesalers. These problems are likely to arise when a product can be made from a variety of available raw materials of various composition and prices. The manufacturing process involves mixing-some if these materials in varying quantities ot make a product conforming to given specifications. The supply of raw materials and specifications serve as constraints in obtaining the minimum cost material blend. The solution would state the number of units of each raw material which are to be blended to make one unit of product. And food industry such as blending input ingredients to produce soft drinks soups and so on. In most of these applications management may decide how much of each resource to purchase in order to satisfy product specifications and product demands at minimum cost. Using transportation technique of linear programming we can determine the distribution system that will minimize total shipping cost from several warehouses to various market locations. These problems occur when the products needed by the various destinations in a transportation problem do not list in finished form but rather must be manufactured at the sources before shipment. The sources may have different production costs. The problem then is to minimize cost by deciding what is to be produced at each source and where the goods are to be shipped. In a number of manufacturing situations, products are made in standard sizes e. The problem is to determine which combination of requirements should be produced from standard materials in order to keep trim loss to a minimum. Given the restraints of the capacities of the various manufacturing units together with the types of residual fuels available and the market prices of finished products the model can be solved to indicate the quantity of each product that should be manufactured if profits are to be maximized. LP methods are used in solving problems involving facilities for transmission switching relaying, etc. An LP model for optimal programming of railway freight and train movements has been formulated to handle scheduling problems as fond at large terminal switching rail points. The constraints of the model were based on the methods of hiring and paying the trainmen, the scheduling of shipment and the capacity limitations of rail road, the objective being to minimize the total crew and engine expenses.

3: Linear Programming - Math Central

Manufacturing and service industry uses linear programming on a regular basis. In this section, we are going to look at the various applications of Linear programming. Manufacturing industries use linear programming for analyzing their supply chain operations.

Linear Programming Natasha Glydon Consider this scenario: The sewing teachers are also willing to help out. Considering the number of people available and time constraints due to classes, only toques and pairs of mitts can be made each week. Enough material is delivered to the school every Monday morning to make a total of items per week. In order to make the most money from the fundraiser, how many of each item should be made each week? It is important to understand that profit the amount of money made from the fundraiser is equal to the revenue the total amount of money made minus the costs: Because the students are donating their time and the community is donating the material, the cost of making the toques and mitts is zero. If the quantity you want to optimize here, profit and the constraint conditions more on them later are linear, then the problem can be solved using a special organization called linear programming. Linear programming enables industries and companies to find optimal solutions to economic decisions. Generally, this means maximizing profits and minimizing costs. Constraints are limitations, and may suggest, for example, how much of a certain item can be made or in how much time. Creating equations, or inequalities, and graphing them can help solve simple linear programming problems, like the one above. We can assign variables to represent the information in the above problem. This is one restriction. This is the material restriction. This means that we cannot make -3 toques. Our final equation comes from the goal of the problem. We want to maximize the total profit from the toques and mitts. In some applications, the linear equations are very complex with numerous constraints and there are too many variables to work out manually, so they have special computers and software to perform the calculations efficiently. Sometimes, linear programming problems can be solved using matrices or by using an elimination or substitution method, which are common strategies for solving systems of linear equations. Using the equations and inequations generated above, we can graph these, to find a feasible region. Our feasible region is the convex polygon that satisfies all of the constraints. In this situation, one of the vertices of this polygon will provide the optimal choice, so we must first consider all of the corner points of the polygon and find which pair of coordinates makes us the most money. From our toque and mitt example, we can produce the following graph: We can see that our feasible region the green area has vertices of 0, , , 0 , , 50 , and 80, By substituting these values for x and y in our revenue equation, we can find the optimal solution. Therefore, the sewing students and teachers must make 80 toques and pairs of mitts each week in order to make the most money. We can check that these solutions satisfy all of our restrictions: We know that we will have enough material to make 80 toques and pairs of mitts each week. We can also see that our values for x and y are less than and , respectively. So, not only is our solution possible, but it is the best combination to optimize profits for the school. This is a fairly simple problem, but it is easy to see how this type of organization can be useful and very practical in the industrial world. Airlines The airline industry uses linear programming to optimize profits and minimize expenses in their business. Initially, airlines charged the same price for any seat on the aircraft. In order to make money, they decided to charge different fares for different seats and promoted different prices depending on how early you bought your ticket. This required some linear programming. Airlines needed to consider how many people would be willing to pay a higher price for a ticket if they were able to book their flight at the last minute and have substantial flexibility in their schedule and flight times. The airline also needed to know how many people would only purchase a low price ticket, without an in-flight meal. Through linear programming, airlines were able to find the optimal breakdown of how many tickets to sell at which price, including various prices in between. There are certain standards that require pilots to sleep for so many hours and to have so many days rest before flying. Airlines want to maximize the amount of time that their pilots are in the air, as well. Pilots have certain specializations, as not all pilots are able to fly the same planes, so this also becomes a factor. Because all of these constraints must be considered when making economic decisions about the airline, linear programming becomes a crucial job. The

Manufacturing Industry Many other industries rely on linear programming to enhance the economy of their business.

4: Linear programming - Wikipedia

It is a progress report on applications of linear programming by a number of oil companies. Examples are presented of applications to a variety of problems arising in the areas of Drilling and Production, Manufacturing, and Marketing and Distribution.

Using linear programming allows researchers to find the best, most economical solution to a problem within all of its limitations, or constraints. Many fields use linear programming techniques to make their processes more efficient. These include food and agriculture, engineering, transportation, manufacturing and energy. It is used to make processes more efficient and cost-effective. Some areas of application for linear programming include food and agriculture, engineering, transportation, manufacturing and energy. Linear Programming Overview Using linear programming requires defining variables, finding constraints and finding the objective function, or what needs to be maximized. In some cases, linear programming is instead used for minimization, or the smallest possible objective function value. Linear programming requires the creation of inequalities and then graphing those to solve problems. While some linear programming can be done manually, quite often the variables and calculations become too complex and require the use of computational software. Food and Agriculture Farmers apply linear programming techniques to their work. By determining what crops they should grow, the quantity of it and how to use it efficiently, farmers can increase their revenue. Sciencing Video Vault In nutrition, linear programming provides a powerful tool to aid in planning for dietary needs. In order to provide healthy, low-cost food baskets for needy families, nutritionists can use linear programming. Constraints may include dietary guidelines, nutrient guidance, cultural acceptability or some combination thereof. Mathematical modeling provides assistance to calculate the foods needed to provide nutrition at low cost, in order to prevent noncommunicable disease. Unprocessed food data and prices are needed for such calculations, all while respecting the cultural aspects of the food types. The objective function is the total cost of the food basket. Linear programming also allows time variations for the frequency of making such food baskets. Applications in Engineering Engineers also use linear programming to help solve design and manufacturing problems. For example, in airfoil meshes, engineers seek aerodynamic shape optimization. This allows for the reduction of the drag coefficient of the airfoil. Constraints may include lift coefficient, relative maximum thickness, nose radius and trailing edge angle. Shape optimization seeks to make a shock-free airfoil with a feasible shape. Linear programming therefore provides engineers with an essential tool in shape optimization. Transportation Optimization Transportation systems rely upon linear programming for cost and time efficiency. Bus and train routes must factor in scheduling, travel time and passengers. Airlines use linear programming to optimize their profits according to different seat prices and customer demand. Airlines also use linear programming for pilot scheduling and routes. Efficient Manufacturing Manufacturing requires transforming raw materials into products that maximize company revenue. Each step of the manufacturing process must work efficiently to reach that goal. For example, raw materials must past through various machines for set amounts of time in an assembly line. To maximize profit, a company can use a linear expression of how much raw material to use. Constraints include the time spent on each machine. Any machines creating bottlenecks must be addressed. The amount of products made may be affected, in order to maximize profit based on the raw materials and the time needed. Energy Industry Modern energy grid systems incorporate not only traditional electrical systems, but also renewables such as wind and solar photovoltaics. In order to optimize the electric load requirements, generators, transmission and distribution lines, and storage must be taken into account. At the same time, costs must remain sustainable for profits. Linear programming provides a method to optimize the electric power system design. It allows for matching the electric load in the shortest total distance between generation of the electricity and its demand over time. Linear programming can be used to optimize load-matching or to optimize cost, providing a valuable tool to the energy industry.

5: Business Uses of a Linear Programming Model | Bizfluent

Production Planning. Linear programming methods are often helpful at solving problems related to production. A company that produces multiple types of products can use linear programming methods to calculate how much of each product to produce to maximize its profits.

Volume 1, Issue 2, September , Pages: Maurya To cite this article: American Journal of Biological and Environmental Statistics. October 12, ; Accepted: April 15, ; Published: June 16, Abstract: This paper aims for profit optimization of an Ethiopian chemical company located in Adama Ethiopia using linear programming model. Particularly, our present study brings out clearly the necessity of using quantitative techniques for utilization in Ethiopian company; a factory situated within Adama about 90 kms. The first step comprises data generation. A questionnaire is prepared and circulated amongst company staff both executive and technical to determine the production, sales and profit during a few months of The profits varied considerably owing to subjective approach. It was established that the decisions are undertaken by experienced people without use of quantitative people and quantitative method. Whole approach applied here is seemingly subjective. A theoretical perspective undertaken for the present study is review of various different applications of linear programming. The characteristics of base assumptions of linear programming and its advantages and disadvantages towards establishing its need for optimization are briefly outlined in terms of its application to the factory. Survey data is analyzed to determine the style of decision making and the problem is defined. An objective function is created in terms of decision variables of production, sales and profit over a period of time using the quantitatively available data of these parameters. A linear programming model for company is developed for profit optimization. The model equations with adequate restraints taking into account manufacturing limitations are solved using MS-Excel solver. Finally, some conclusive observations have been drawn and recommendations have been suggested. Profit optimization, linear programming model, simplex method, manufacturing limitation, service industries Contents Abstract Keywords 1. Statement of the Problem 3. Objectives and Research Questions 3. Objectives of the Study 3. Significance of the Study 5. Data and Methodology 5. Method of Data Collection 5. Method of Data Analysis 6. LPP Model and its Application 6. The Proposed Model 6. Assumptions of the Model 6. Application and Analysis 6. The Decision Approach of the Company 6. LPP of the Chemical Company 6. Conclusive Observations Recommendations References 1. Introduction Linear Programming LP is a problem-solving approach developed to help managers make decisions. The term linear programming was first used by G. Dantzig [2] in to refer to specific problems of optimization which assume that both constraints and objective function are linear. As with other branches of Operations Research, the first applications of LP are found in military planning activities, how to distribute men, weapons, and supplies efficiently to the various fronts during World War II. Here, the word programming means creating a plan that solves a problem; it is not a reference to computer programming. Soon after that, LP came into wide use in industry, with the most fruitful utilization in the petroleum, petrochemical and food industries extensive references can be found in Dantzig [2] and [3]. Linear Programming is not a new modeling technique: The mathematics of linear programming are well established and presented in number of books [3],[4], [5], [6] while computer packages for solving large LP models are well developed and widely available, e. Linear programming is one specialized mathematical decision-making aid. It can be applied to many problems in the real world, not because the world is linear but because it is a powerful problem-solving technique. Here, the researches carried out by Kim [7] and Mehdipoor et al. Linear programming, or linear optimization, is a mathematical method to achieve the minimum or maximum value of a linear function on a convex polyhedron. To put simply, one can achieve the best outcome e. While linear programming is mainly used in management and economics, it can also be utilized for some engineering problems. Linear programming uses a mathematical model to describe the problem of concern. Thus, linear programming involves the planning of activities to obtain an optimal result, i. Although allocating resources to activities is the most common type of application, linear programming has numerous other important applications as well. In fact, any problem whose mathematical model fits the very general format for the linear programming model is a linear programming problem. Furthermore, a remarkably efficient solution procedure, called the simplex method, is available for solving linear programming problems of even enormous size [9]. These are some of the reasons for the tremendous impact of linear programming in recent decades [5]. As stated above, linear programming was developed as a mathematical pattern during World War II to plan expenditures and returns in order to reduce costs to the army and increase losses to the enemy. The method was kept secret until After the war, many industries began using it. The founders of linear programming are: Dantzig who published the simplex method in , John von Neumann who developed the theory of duality, and Leonid Kantorovich - the Russian mathematician who applied similar techniques before Dantzig, and won the Noble Prize in Owen [10] has also used the linear programming method to design antenna array patterns that suppress interference from certain directions. Statement of the Problem Linear programming is a set of techniques and methods inferred from mathematics and other sciences which can play an efficient role in improving the management decisions. Although it is still regarded as a new science, but it has well proved to be capable of solving problems such as production planning, allocating resources, inventory control, and advertising. Those managers who care about the best outcomes for their decisions cannot be indifferent to this. Wijeratne and Harris [11] proposed that the linear programming model is used by the managers to determine the most economical arrangement of finance, to arrange the best times to start and finish projects, and to select projects to minimize the total net present cost of capital. Linear programming optimizes maximizing or minimizing a dependent variable subject to a set of independent variables in a linear relationship, given a number of linear constraints of independent variables. The value of dependent variables which is the value obtained from solving the problem, is subject to the independent variables set by the decision maker or determined by solving the problem. The dependent variables are usually set as objective function which may be one of the economic concepts such as profit, cost, income, production, sales, distance and time, etc. The independent variables in linear programming are known as variables of unknown value, and the decision maker has to calculate the value of such variables by solving the problem [13]. In Ethiopia, most decisions were taken by government or non-governmental organizations, whether it is profitable or not for companies, manufacturing or service industries are based on trial and error. Qualitative decisions, like intuition, judgmental approaches are more dominant and the application of model based decision making like optimization techniques, e. Hence, it is initiated by author to conduct an assessment of the application of linear programming in this particular company as a case study. Objectives of the Study The main objectives of this paper are: Significance of the Study It helps to understand the best way of making decisions using quantitative models in order to determine its optimal product-mixes that can maximize its profits subject to the scarce resources it has. The study will provide a deep understanding and insight of the applications of linear programming models in industries and how to apply such models in practical and real world experience. To other researchers of similar interest who are willing to undertake further investigation on the topic, this research document can be used as a secondary information source. This research paper is structured in seven sections. Finally, some recommendations are illustrated in the end. This study was conducted for three reasons. Firstly, there was no reliable and comprehensive study to examine the role of linear programming in companies in Ethiopia. Secondly, it might pave the way forward for the company, policy makers, and financial institutions to understand the different roles of institutions in the development process. Finally, this study advances the knowledge of linear programming in decision making. Method of Data Collection In order to gather the relevant data from the company producing sulfuric acid, oleum and Aluminum sulfate utilizing partially locally available raw materials. This paper was based on primary and secondary sources of data. Especially to get information on the decision making practice of the company under study, an interview was conducted with the manufacturing manager and the sales managers of the company and data collected on the unit costs of production of the products, the unit selling price of the products and also contacted the sales and the purchasing, production and marketing managers of the company. And additionally secondary data sources were used to get accurate information. Method of Data Analysis Collected data were presented in a narrative form and analyzed using linear programming model. Since the purpose of this study was to develop linear programming model for the collected data from the company, the authors tried to transform the data into a linear programming model and solved the model problem using simplex algorithm using by applying MS-Excel solver in order to determine the optimal combination of the products of the company that can maximize its profit within the available scarce resources. Simplex algorithm was preferred over graphical approach because of this method can help to solve linear programming problems of any number of decision variables. Excel solver was preferred for accuracy purpose. LPP Model and its Application Linear Programming is a mathematical technique for generating and selecting the optimal or the best solution for a given objective function. Technically, linear programming may be formally defined as a method of optimizing i. According to Fagoyinbo [5], Williams [12] and Wood and Dantzig [13] the problem of LP stated as that of the optimization of linear objective function of the following form: The Proposed Model The objective function and constraints were used in the following general form: Estimates of the variables are presented in tables. The optimum values of the different brands produced by the firm shows the combination product mix obtained through the application of linear programming model. Assumptions of the Model For applying the proposed model to case of profit optimization, following assumptions were taken into consideration: The contribution of each activity to the value of the objective function Z is proportional to the level of the activity xj, as represented by the terms cjxj in the objective function. Similarly, the contribution of each activity to the left-hand side of each functional constraint is proportional to the level of the activity xj, as represented by the terms aijxj in the constraints.

6: Airlines and Linear Programming - Math Central

Restaurants use linear programming for menu planning. It uses basic algebra to optimize meal production and thereby increase restaurant profits. Linear algebra reflects a direct relationship.

John von Neumann The problem of solving a system of linear inequalities dates back at least as far as Fourier , who in published a method for solving them, [1] and after whom the method of Fourierâ€"Motzkin elimination is named. In a linear programming formulation of a problem that is equivalent to the general linear programming problem was given by the Soviet economist Leonid Kantorovich , who also proposed a method for solving it. Koopmans formulated classical economic problems as linear programs. Kantorovich and Koopmans later shared the Nobel prize in economics. During â€", George B. Dantzig independently developed general linear programming formulation to use for planning problems in US Air Force[citation needed]. In , Dantzig also invented the simplex method that for the first time efficiently tackled the linear programming problem in most cases[citation needed]. When Dantzig arranged a meeting with John von Neumann to discuss his simplex method, Neumann immediately conjectured the theory of duality by realizing that the problem he had been working in game theory was equivalent[citation needed]. Dantzig provided formal proof in an unpublished report "A Theorem on Linear Inequalities" on January 5, The computing power required to test all the permutations to select the best assignment is vast; the number of possible configurations exceeds the number of particles in the observable universe. However, it takes only a moment to find the optimum solution by posing the problem as a linear program and applying the simplex algorithm. The theory behind linear programming drastically reduces the number of possible solutions that must be checked. The linear programming problem was first shown to be solvable in polynomial time by Leonid Khachiyan in , [4] but a larger theoretical and practical breakthrough in the field came in when Narendra Karmarkar introduced a new interior-point method for solving linear-programming problems. Many practical problems in operations research can be expressed as linear programming problems. A number of algorithms for other types of optimization problems work by solving LP problems as sub-problems. Historically, ideas from linear programming have inspired many of the central concepts of optimization theory, such as duality, decomposition, and the importance of convexity and its generalizations. Likewise, linear programming was heavily used in the early formation of microeconomics and it is currently utilized in company management, such as planning, production, transportation, technology and other issues. Although the modern management issues are ever-changing, most companies would like to maximize profits and minimize costs with limited resources. Therefore, many issues can be characterized as linear programming problems. Standard form[edit] Standard form is the usual and most intuitive form of describing a linear programming problem. It consists of the following three parts: A linear function to be maximized e.

7: Linear Programming - IBM Decision Optimization: on Cloud, for Bluemix

Linear programming (LP, also called linear optimization) is a method to achieve the best outcome (such as maximum profit or lowest cost) in a mathematical model whose requirements are represented by linear relationships.

There are further aspects of a refinery, such as the utilities fuel, steam, hydrogen, etc but we shall disregard them here. We shall also defer to another article the issue of how to represent time and assume that we are working with a single time period. Each of the bulleted items is a class of objects which behaves in fundamentally the same way from refinery to refinery and from area to area within a single refinery. We shall explore each of these objects in turn. Materials The concept of a material within a refinery model is, paradoxically, both obvious and highly complex. Oil refineries import crude oil, distill it into fractions such as naphtha, kerosine and gas oil, process some fractions further into components such as cracked distillate and alkylate and then blend various of these together to make finished products such as UK regular unleaded petrol. For each of these materials a refinery engineer could point to a pipe which contained the material and, for some of them, to one or more tanks as well. Thus these substances with names have physical reality and are "materials". But there is more to a material than this. Take crude oil, for instance. There are many different crude oils, and they vary in their physical characteristics density, sulphur content, waxiness, etc and their price. There may be several crude tanks at a refinery but there will be a single pipe which delivers the crude feed to a crude distillation unit CDU. As far as the CDU is concerned, it processes a single material, crude oil, but the composition of this material will change, depending on the crudes which the refinery has imported and which crude tank is on feed to the CDU. Thus the composition of a material will change through time. This extends throughout the refinery with the exception of the simplest products, such as methane and propane, which are chemically well-defined. Now in building a model of the refinery, our main decision variables will be the quantities of each material which we are using and what we are doing with it processing it, blending it into one product or another, etc. So what we would like to be able to do is to have decision variables for: This inevitably leads us into a model in which we are working with products of decision variables, i. This is indeed what is increasingly done in refinery models. But there is an alternative, in which the model is kept linear and which is the basis of the "traditional" refinery LP model. In this a single physical material within the refinery is represented by several distinct "grades", just as the single pipe conveying crude oil to the CDU can contain many distinct crudes. Each of these grades has a well-defined and constant set of qualities. The single physical material is represented as the sum of various quantities of the grades, which are defined so as to be able to represent the full range of variability of the physical material. This leads to purely linear constraints and ensures that the various qualities of the materials are conserved, but it gives the model the unrealistic extra freedom to use each of the grades separately. For instance, suppose that the reformer process unit is making reformate of 96 octane. The 96 octane reformate may be represented as a The model might then say that it will use the 97 octane reformate in making 97 octane petrol and the 95 octane reformate in making 91 octane petrol. In fact there is no 97 octane reformate and the model cannot meet the quality specification for 97 octane petrol while running the reformer at 96 octane. The nonlinear model would not make this mistake because it would represent the reformate as a single stream of 96 octane. But this is also not entirely realistic. In practice the qualities of materials do vary through time, for instance to reflect the different crudes being processed. A process unit may also be run in campaigns with different operating conditions to produce variants of a single material, e. In this case the traditional LP model is closer to reality, although it may still do unrealistic things such as blending 97 octane reformate with another component which is only available at a mutually exclusive time. Process Units A process unit may have several feeds. Most often these can be considered as independent and for each one a set of output materials can be defined together with their yields. The process unit may have a number of control parameters e. The representation of yields and qualities by feeds and process conditions is usually the most complex part of the data set for a refinery model. With a traditional LP model the feeds are the "grades" of the physical materials. In the same way that the LP representation has to handle variable qualities of materials as combinations of grades, so it represents variable process conditions as combinations of process "modes", e. The yields of each "grade" of output material must be defined for each "grade" of input material and each process mode. As some of the grades are fairly artificial, this may require some interpolation and extrapolation from observed data. It is somewhat easier for the nonlinear model. Each feed is considered to be broken down into its assay components. Crude oil consists of an enormous variety of hydrocarbons with boiling points from, say, 20oC to oC. If one divides this into successive 10oC increments, the hydrocarbons within each increment are fairly similar and it make sense to define the yield for each of these assay components for each process unit. Process modes may still be used to represent the variation in process conditions; alternatively a "base-delta" representation may be used. In this there is a "base" set of yields and then a "delta" set which shows how the yields change as the control parameter varies. Finished Products Each finished product is associated with a quality specification, i. For each product there is a demand which must be met and for some there is the possibility of making a surplus for spot sales. Finished products are therefore well-defined and do not require the artificial creation of "grades" as for other materials. In practice, finished products are quite close to being grades of a parent material. For instance, there will be a certain pipe and set of tanks which hold unleaded petrol. At different times different types of unleaded petrol will be being made but the same facilities will be used for each. LP-based models, whether linear or not, represent the total storage capacity for such variant materials and do not attempt to sort out the sequence in which the different variants should be made or which tanks should be used for each. Blending Blending in oil refineries is similar to blending in other industries. In essence you are bringing together a number of components to meet a quality specification. In the traditional LP model the components are the "grades" of the physical streams within the refinery; in the nonlinear model they are the streams themselves. As each "grade" of the traditional model has constant qualities, this gives rise to the typical quality constraints of LP models. But the model has the freedom to decide how much of each "grade" to include in the blend. This leads to over-optimization, i. In the nonlinear approach, each of the components of a blend is a physical stream with what amounts to the average qualities of that stream through the schedule period. But there may be times when this is what you do want to do, e. Thus the nonlinear model tends to under-optimize and fails to suggest which products should be made using which crudes and which process modes. Qualities Some qualities, such as specific gravity and sulphur content, do blend linearly. Other qualities blend in a nonlinear way but without complex interactions between components. For most of these, engineers have developed "linear blend indices" which transform the measured qualities into index values which can be constrained using ordinary linear constraints. There remain some qualities which are so nonlinear that blend indices do not work. In a traditional LP model, a linear approximation to their behaviour is used which is based on the typical composition of the blend. Extra constraints are imposed to ensure that the composition of the blend does not stray too far. A nonlinear model represents such relationships directly.

8: Introductory guide on Linear Programming explained in simple english

Linear programming is used to obtain optimal solutions for operations research. Using linear programming allows researchers to find the best, most economical solution to a problem within all of its limitations, or constraints.

The Simplex algorithm, invented by George Dantzig in became the basis for the entire field of mathematical optimization and provided the first practical method to solve a linear programming problem. Of course, CPLEX evolved over time to embrace and become a leader in the children categories of linear programming, such as integer programming, mixed-integer programming and quadratic programming, too. Depending on how familiar you are with linear programming, you may be interested in various levels of information around linear programming and how they are handled by CPLEX. The information presented below goes from the highest level fundamental explanation of what linear programming is and how it runs in CPLEX down to more advanced notions. At the end, you will also find some external classic references on linear programming. As abstract as the mathematics appears to be, it has powerful capabilities that enable businesses to reduce costs, improve profitability, use resources effectively, reduce risks, and provide benefits in many other key dimensions. Furthermore, optimization can automate decision processes to improve speed of responses and allow managers to focus their attention on critical uncertainties rather than routine matters. And these benefits have been demonstrated in numerous real-world implementations. Get your feet wet by first understanding what optimization can do for your business. Linear Programming The concept behind a linear programming problem is simple. It consists for four basic components: Decision variables represent quantities to be determined Objective function represents how the decision variables affect the cost or value to be optimized minimized or maximized Constraints represent how the decision variables use resources, which are available in limited quantities Data quantifies the relationships represented in the objective function and the constraints In a linear program, the objective function and the constraints are linear relationships, meaning that the effect of changing a decision variable is proportional to its magnitude. While this requirement may seem overly restrictive, many real-world business problems can be formulated in this manner. That provides a powerful and robust analytical methodology for supporting fact-based decision making. If you want to decide how to supply of each kind of product in order to minimize your costs, you have to do that within a set of constraints. For instance you have to be able to produce enough to satisfy the demand on all your various products and you have to do it within the capacity you have, which can produce units at a given cost. A manufacturer wants to sell a product. The product can either be made inside the factory or purchased outside. Inside production uses scarce capacity, and there is an inside cost per unit to manufacture. Outside acquisition has a higher outside cost per unit to purchase but uses none of the scarce capacity. Using both sources, all demand must be satisfied. The goal is to minimize total cost. For linear programming, there are fast implementations of the primal simplex algorithm, the dual simplex algorithm, the network simplex algorithm, as well as a barrier method.

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Linear programming was revolutionized when CPLEX software was created over 20 years ago: it was the first commercial linear optimizer on the market written in the C language, and it gave operations researchers unprecedented flexibility, reliability and performance to create novel optimization.

LINEAR PROGRAMMING IN INDUSTRY pdf

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