I'm not a robot

Introduction Non-linear Programming (NLP) adds a layer of complexity to optimization problems by incorporating non-linear functions. This article explores the modeling of Non-linear Programming using Microsoft Excel Solver. We will embark on this journey by presenting an example problem statement, demonstrating the data setup in Excel, and showcasing the step-by-step process of leveraging Solver to optimize non-linear models. Example Problem Statement Let's consider a classic non-linear optimization problem. You want to maximize the profit (P) of a product based on the quantity produced (Q) and the production cost (C). The profit function is given by: However, there is a constraint on the production cost, C, which should not exceed $5000. Solving the Problem Step 1: Formulate the Objective Function: The objective is to maximize the profit P based on the quantity produced Q and the production cost C. The profit function P is given by: $P = 20*Q - 2*Q^2 - 0.1*C*Q$ Step 2: Set Up the Constraint: There is a constraint on the production cost C, which should not exceed $5000: Step 3: Find the Critical Points: To find the critical points where the profit is maximized, we need to find the first-order partial derivatives of the profit function with respect to Q and C, and set them equal to zero: $\partial P / \partial Q = 20 - 4*Q - 0.1*C = 0$ Solving these equations simultaneously will give us the critical points. Step 4: Check the Second Derivatives: To determine whether each critical point is a maximum or minimum, we need to compute the second-order partial derivatives of the profit function with respect to Q and C, and evaluate them at the critical points: Step 5: Verify Constraints: Verify that the critical points satisfy the constraint $C \leq 5000$. Step 6: Determine the Maximum Profit: Once you have identified the critical points that satisfy the constraint and determined their nature (maximum, minimum, or saddle point), evaluate the profit function at these points to find the maximum profit. By following these steps, you can systematically solve the non-linear optimization problem and determine the quantity produced Q and the production cost C that maximize the profit for the given scenario. Setting Up the Excel Worksheet Define Decision Variables: Open a new Excel worksheet. In cell B2, label it "Quantity (Q)". This cell will be our decision variable. Objective Function: In a cell, let's say C2, label it "Profit (P)". Enter the formula =20*B2 - 2*B2^2 - 0.1*5000*B2 to represent the profit function. Constraint: Introduce a constraint to ensure the production cost does not exceed $5000. In cell D2, label it "Production Cost (C)". Enter the formula =5000. Non-negativity Constraint: Set a non-negativity constraint for the quantity produced: =B2 >= 0. Solver Parameters Dialog Box Click on "Solver" in the "Data" tab. This opens the Solver Parameters dialog box. Set Objective Function and Decision Variables: In the Solver Parameters dialog box, set the objective function cell to C2 and the decision variable cell (By Changing Variable Cells) to B2. Add Constraints: Click on "Add" to enter the constraint for the production cost. Additionally, set the non-negativity constraint. Choose Solving Method: Choose the GRG Nonlinear solving method for non-linear programming problems. Solver Options: Optionally, set additional options based on your requirements. Solve: Click "Solve" in the Solver Parameters dialog box. Solver will analyze the non-linear model and provide the optimal quantity to maximize profit while satisfying the constraints. Once Solver completes its analysis, it will display the optimal quantity in the worksheet. This value represents the quantity to produce for maximizing profit within the given constraints. Conclusion This example illustrates the application of Excel Solver for Non-linear Programming. By skillfully setting up the problem, incorporating constraints, and utilizing the Solver function, organizations can optimize non-linear models efficiently. Excel's Solver provides a versatile and user-friendly platform for tackling complex non-linear programming scenarios, enabling businesses to make informed decisions and maximize outcomes in various fields, from production planning to financial optimization. OR-Notes are a series of introductory notes on topics that fall under the broad heading of the field of operations research (OR). They were originally used by me in an introductory OR course I give at Imperial College. They are now available for use by any students and teachers interested in OR subject to the following conditions. A full list of the topics available in OR-Notes can be found here. Nonlinear programming Introduction You will recall that in formulating linear programs (LP's) and integer programs (IP's) we tried to ensure that both the objective and the constraints were linear - that is each term was merely a constant or a constant multiplied by an unknown (e.g. $5x$ is a linear term but $5x^2$ a nonlinear term). Unless all terms were linear our solution algorithms (simplex/interior point for LP and tree search for IP) would not work. Here we will look at problems which do contain nonlinear terms. Such problems are generally known as nonlinear programming (NLP) problems and the entire subject is known as nonlinear programming. The mathematics of nonlinear programming is very complex and will not be considered here. We will illustrate nonlinear programming with the aid of a number of examples solved using the package. A restricted capacity free copy of some software from Lindo Systems for solving nonlinear programs is available here. Another package is available here. Example Consider the following nonlinear program: minimise $x(\sin(3.14159x))$ subject to 0