CMSC 150 Solvers Application:

User's Manual

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About

CMSC 150 Solvers is an application built for solving Polynomial Regression, Quadratic Spline Interpolation and Simplex Method. It aims to make computations of the said methods easier. It serves as a project in CMSC 150: Numerical and Symbolic Computations.

Getting Started

Prerequisites

To use the application, the following programs must be installed in your computer:

- R Programming Language
- RStudio
- RStudio Shiny Package

If the following programs were not yet installed, visit the following links to download the executable file:

R Programming Language: `www.r-project.org` RStudio: `www.rstudio.com`

To install the Shiny package, type `install.packages("shiny")` in your RStudio Console.

How to run the application

Before running the application, check the zip file if the following files are present:

- 'src' — the directory that contains the source codes
- 'users_manual.pdf' — a pdf file that contains the User's Manual
- 'READ.me' — a text file that contains the instruction for installing and running the application

Open the `src` folder, it should contains two R Scripts:

- app. R— contains code for the UI
- solvers.R— contains the functions needed to solve the methods

Double click `app.R` to open. It should open in the RStudio Environment. On the upper right corner, you can see a `Run App` button. Click the button to run the application

How to use

Generally, the application is very easy to use. It has three separate solvers tab, one for Polynomial Regression, one for Quadratic Spline Interpolation, and one for Simplex Method. The following functionalities will be describe on the following subsections.

Polynomial Regression

Polynomial Regression is used when the data has a lot of noise. It can be used for estimating trends depending on the degree of the polynomial. This application can read a csv file, accept inputs like the order/degree of the polynomial and the value to be estimated.

- Import CSV File— To import a csv file, click the `browse` button and find the file with extension `.csv` in your computer. When you found the file, click open. A blue bar will appear when you successfully uploaded the data.

Note that the file must have a proper arrangement. The data points must be arranged in this order: `x,y` followed by a new line. Also, headers must be excluded in the file.

- Put the order of the polynomial— When putting the value, make sure that it is a positive integer. Avoid negative values and zero, those values will produce an error.
- Put the value you want to estimate— In Polynomial Regression, there is no restricted value to be estimated.
- Click `Solve`— by clicking solve, it will compute the function for the model and estimate the value. Always remember to click `Solve` when you want to change the degree of the polynomial and the value to be estimated.

To know the output, read the Features section of the manual.

Quadratic Spline Interpolation

Unlike Polynomial Regression, Interpolation is used when you have precise data and has no or has very few noise. The interpolating function always passes through all the data points. However, it can only estimate values within the range of the data points.

Quadratic Spline Interpolation is one of the many methods to interpolate. This particular method provides n functions given $n+1$ data points. The functions are in the form of a quadratic equation: ax^2+bx+c. It creates a parabola between data points. Hence naming it, Quadratic Spline Interpolation.

- Import CSV File— To import a csv file, click the `browse` button and find the file with extension `.csv` in your computer. When you found the file, click open. A blue bar will appear when you successfully uploaded the data. The data points are always sorted upon uploading.

Note that the file must have a proper arrangement. The data points must be arranged in this order: `x,y` followed by a new line. Also, headers must be excluded in the file.

- Put the value you want to estimate— Since it is an interpolation method, it only allows values within the range of the smallest and largest x value. Putting values within the range can cause an error.
- Click `Solve`— by clicking solve, it will compute the functions per interval and estimate the value. Always remember to click `Solve` when you want to change the value to be estimated.

To know the output, read the Features section of the manual.

Simplex Method

Simplex Method is a numerical method to optimize problems. It can maximize profit or minimize cost. For this application, it solves this particular minimization problem:

ASSESSING THE VALUE OF SUPPLY CHAIN MANAGEMENT OPTIMIZING SHIPMENTS

One of the main products of the Fairway Woods Company is custom-made golf clubs. The clubs are manufactured at three plants (Denver, Colorado; Phoenix, Arizona; and Dallas, Texas) and are then shipped by truck to five distribution warehouses in Sacramento, California; Salt Lake City, Utah; Albuquerque, New Mexico; Chicago, Illinois; and New York City, New York. Because shipping costs are a major expense, management is investigating a way to reduce them. For the upcoming golf season, an estimate has been created as to the total output needed from each manufacturing plant and how each warehouse will require satisfying its customers. The CIO from Fairway Woods Company has created a spreadsheet of the shipping costs from each manufacturing plant to each warehouse as a baseline analysis.

For this problem, the minimum total cost of the shipping fee is the final answer together with the number of products per plant.

This application has 23 inputs, 3 for supplies, 5 for demands and 15 for costs.

- Putting inputs — the supplies, demands and costs must be a positive integer. Negative values will make the solution incorrect. Be aware of the label before putting the values, supplies are in the first input fields, then demands and finally the costs.
- Choose the values you want to display— this application has three options to display: initial tableau, tableau per iteration and basic solution per iteration.

- Click `Solve`— by clicking solve, it will compute the minimum cost . Always remember to click `Solve` when you want to change the values of the constraints

To know the output, read the Features section of the manual.

Features

After clicking Solve, several features of the application will appear, it will help you analyze and understand the data. Below are the descriptions of those features.

Table of Data Points

For Polynomial Regression and Quadratic Spline Interpolation, after uploading the data, it will be sorted while after clicking Solve, it will be displayed below the Solve button and can be the basis of estimated value. It is very helpful in Quadratic Spline Interpolation since it will serves as the guide for the range of values allowed to be estimated.

Plot of Data Points

For Polynomial Regression and Quadratic Spline Interpolation, after clicking Solve, it will show the plot of the data points. It can help the user visualize the trend of the data and it can also serves as the basis for the function of the graph.

Graph of the Function

For Polynomial Regression and Quadratic Spline Interpolation, after clicking Solve, it will show the graph of the function based on the computations. For Regression, this graph changes depending on the order of the polynomial. For Interpolation, this will change when the value to be estimated was changed. The graph will depend on which interval the value

Displaying the Functions

For Polynomial Regression, it will display a single function based on the order of the polynomial while for Quadratic Spline Interpolation it will display *n* functions given *n+1* data points.

Displaying the Estimated Value

For Polynomial Regression and Quadratic Spline Interpolation, after clicking Solve, the Estimated Value can be seen on the lower part of the Main Panel. It changes depending on the values that were placed by the user. Giving invalid inputs will not give an estimated value.

Initial Tableau

In Simplex Method, there is an option to view the Initial Tableau. Upon checking the checkbox the Initial Tableau will appear with headers from a to o, those labels are for the 15 unknowns. The y headers are for the slack variables. The last column on the table will be the for the Solution. The last row will have negative values of the demand and positive values of the supplies. In this state, the minimum cost is always zero.

Tableau per Iteration

In Simplex Method, there is an option to view the Tableau per Iteration. Upon checking the checkbox, all tableau per iterations can be seen, just like the initial tableau, it has the same header. This time the values can be seen changing per iteration to solve the minimum cost. This can help the user understand the computation of the cost. The maximum number of iteration for this application is 1000. Unlike the initial tableau, this will be displayed in text form to lessen the space covered in the application.

Basic Solution per Iteration

Similar to the previous subsections, this can be seen by checking the checkbox on the Simplex Method options below the solve button. This will provide all the basic solution per iteration in table form. The second column shows the price per plant while the 5 succeeding columns shows the number of products. The last row in the second column is the minimum cost.

Displaying the Solution Table

In Simplex Method, after clicking the Solve button, it will display the final solution table after several iterations. It has 5 rows and 7 columns, the second column will show the costs per plant and the total minimum cost. The succeeding 5 columns will show the number of products to be shipped from one plant to another. This solution table is not always the optimized solution. To know if it is the optimized solution, always check the warning on top of the panel.

Displaying Warning Prompter

To know if the user got the optimized solution, this can be the guide. This will show a message if the solution is optimized or if there is no feasible solution. It can be found on top of the panel. It will be displayed when the Solve button is clicked and there are proper input values.

End of User's Manual