R CMSC 150 USER MANUAL

Introducing a versatile application designed to establish diverse problem-solving challenges as a generic solver, seamlessly addressing three key functionalities: Polynomial Regression, Quadratic Spline Interpolation, and Diet Optimization using the Simplex Method.

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CMSC 150 - AB5L

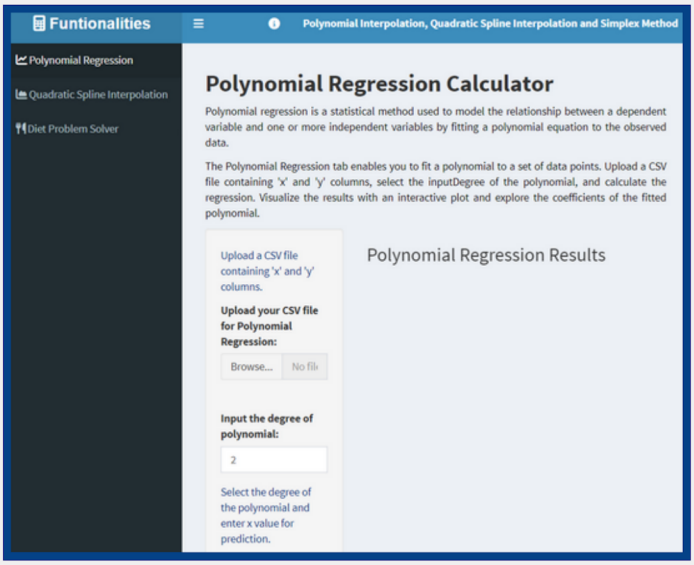
INTRODUCTION OF APPLICATION SOLVERS

Polynomial Regression, Quadratic Spline Interpolation and Diet Problem Solver

Introduction of Application Solvers

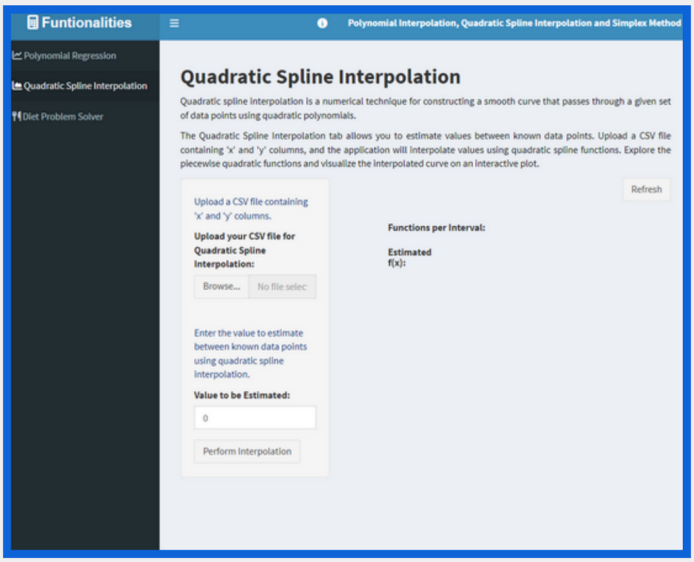
Introduction

The Shiny app presented here offers a user-friendly interface for Polynomial Regression, Quadratic Spline Interpolation, and solving a diet optimization problem using the simplex method. It employs interactive plots, data tables, and informative text to guide users through the analysis and interpretation of results, making complex mathematical concepts accessible to a diverse audience.



Polynomial Regression

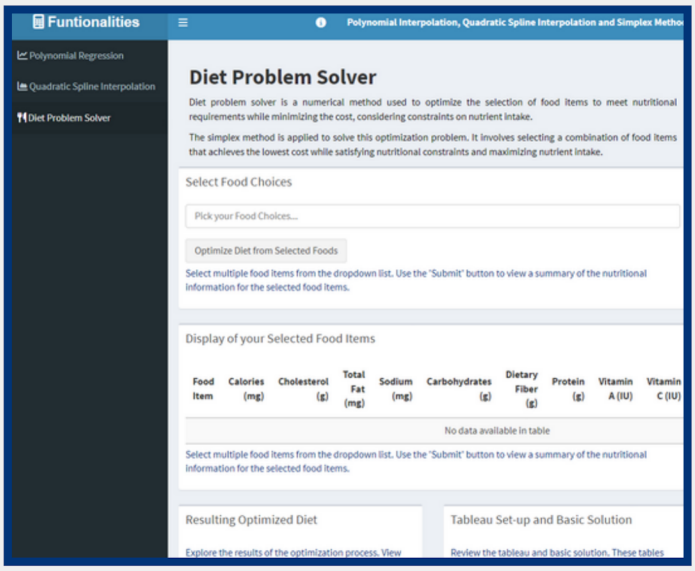
The provided R code implements polynomial regression using Gauss-Jordan elimination. It features detailed comments for clarity, uses descriptive variable names, and checks for unique solutions in the Gauss-Jordan elimination function. The code constructs an augmented coefficient matrix, solves for coefficients, and estimates output for a given value. It prints relevant information about coefficients, estimated values, and the constructed function.



Quadratic Spline Interpolation

The provided R code simplifies quadratic spline interpolation (QSI) using the Gauss-Jordan Elimination method. The function takes data points and a specified x, performs QSI, and outputs a list with quadratic functions for intervals and the predicted value at x. The code ensures continuity and smoothness by meeting conditions at data points and internal knots. Quadratic functions are stored in quadraticFunctions, and the predicted value at x is in y. The function handles cases where x is beyond data point range.

Introduction of Application Solvers



Diet Problem Solver Using Simplex

The provided R code implements a linear programming solver using the Simplex method for a nutritional optimization problem. It includes functions for setting up the problem, solving it iteratively, and formatting the final results. The code initializes matrices for decision variables and slack variables, solves the linear programming problem using the Gauss-Jordan method, and constructs a table with information about the optimal solution. The problem involves finding the optimal combination of food servings to meet nutritional constraints while minimizing cost.

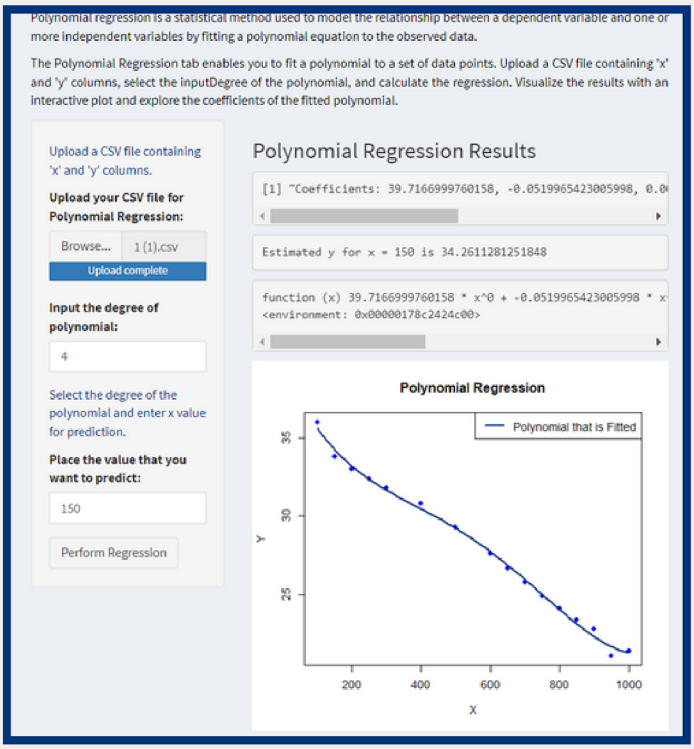
USAGE OF APPLICATION SOLVERS

Polynomial Regression, Quadratic Spline Interpolation and Diet Problem Solver

Usage of Application Solvers

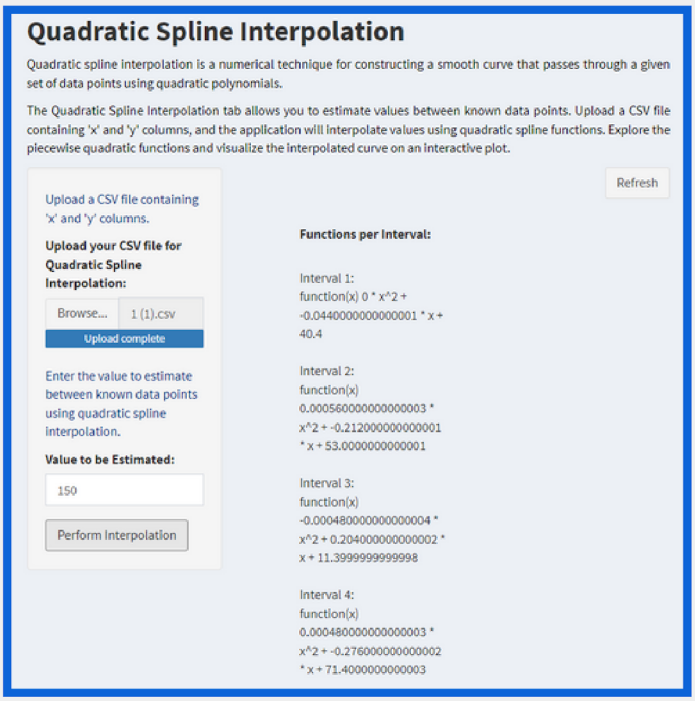
Instruction in using Polynomial Regression Calculator

To utilize the Polynomial Regression Solver in the provided R Shiny application, start by uploading a CSV file containing 'x' and 'y' columns in the "Polynomial Regression" tab. Specify the degree of the polynomial, input the value to predict, and initiate the regression by clicking "Perform Regression." Examine the displayed coefficients, estimated values, polynomial function, and the regression plot to interpret the relationship between 'x' and 'y.' Experiment with different datasets and polynomial degrees for analysis. Reset the inputs and results using the "Reset" button for a fresh analysis. The application is intended for educational and analytical purposes, ensuring your CSV file has valid numerical data in the specified columns for optimal functionality.



Instruction in using Quadratic Spline Interpolation Calculator

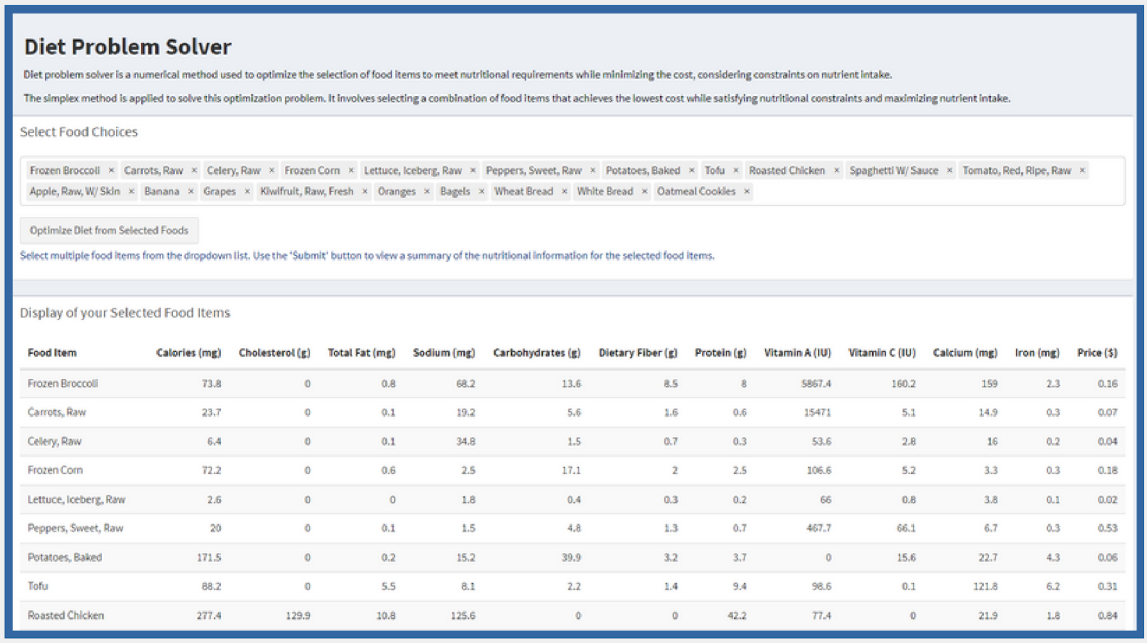
To employ the Quadratic Spline Interpolation Calculator in the R Shiny application, navigate to the "Quadratic Spline Interpolation" tab. Begin by uploading a CSV file with 'x' and 'y' columns, and then enter the value to estimate between known data points. Click "Perform Interpolation" to initiate the calculation. The results will display piecewise quadratic functions per interval and the estimated f(x) value. Ensure your CSV file contains sufficient data points (at least 3), and the lengths of 'x' and 'y' columns are equal. The calculator is designed to provide a smooth curve passing through given data points, allowing users to visualize and understand interpolated values. In case of infeasible scenarios or insufficient data, appropriate messages will guide users.



Usage of Application Solvers

Instruction in using Diet Problem Solver

To operate the Diet Problem Solver within the R Shiny application, head to the "Diet Problem Solver" tab. This numerical optimization tool allows users to select food items and optimize their combination to meet nutritional requirements while minimizing costs and adhering to specific constraints. In the "Select Food Choices" section, use the dropdown to choose multiple food items. To remove a selected food item, click the 'x' icon next to the item in the dropdown list. After selecting the desired food items, click "Optimize Diet from Selected Foods" to initiate the optimization process. View the summary of selected food items in the table below and explore detailed information on nutritional content and cost. The resulting optimized diet, cost breakdown, and other relevant information are displayed in tables within the "Resulting Optimized Diet" section. Use the "Refresh" button to reset and start a new optimization. The application is designed for dietary planning, and users should follow prompts and guidelines to ensure accurate and meaningful results based on their nutritional preferences and constraints.



Diet Problem Solver

Diet problem solver is a numerical method used to optimize the selection of food items to meet nutritional requirements while minimizing the cost, considering constraints on nutrient intake.

The simplex method is applied to solve this optimization problem. It involves selecting a combination of food items that achieves the lowest cost while satisfying nutritional constraints and maximizing nutrient intake.

Select Food Choices

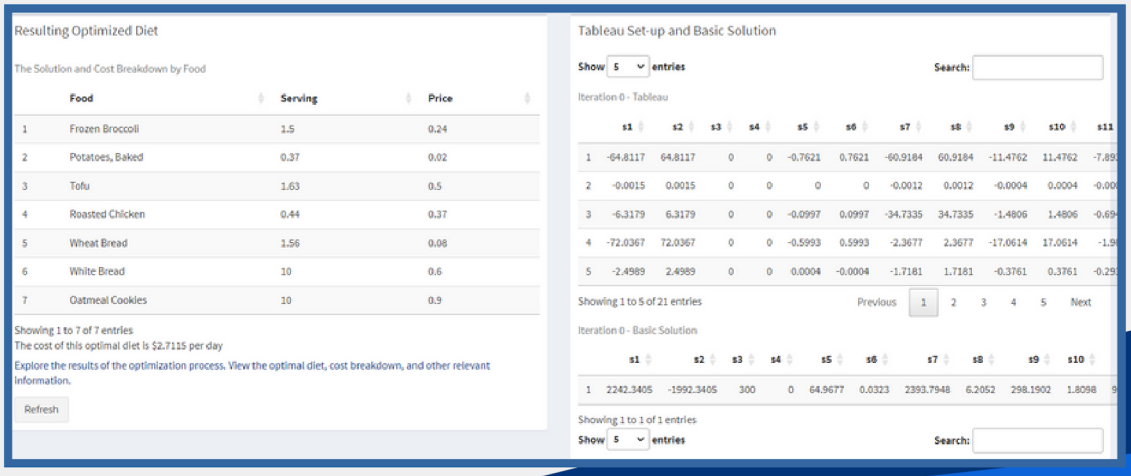
Frozen Broccoli × Carrots, Raw × Celery, Raw × Frozen Corn × Lettuce, Iceberg, Raw × Peppers, Sweet, Raw × Potatoes, Baked × Tofu × Roasted Chicken × Spaghetti W/ Sauce × Tomato, Red, Ripe, Raw × Apple, Raw, W/ Skin × Banana × Grapes × Kiwifruit, Raw, Fresh × Oranges × Bagels × Wheat Bread × White Bread × Oatmeal Cookies ×

Optimize Diet from Selected Foods

Select multiple food items from the dropdown list. Use the 'Submit' button to view a summary of the nutritional information for the selected food items.

Display of your Selected Food Items

Food Item	Calories (mg)	Cholesterol (g)	Total Fat (mg)	Sodium (mg)	Carbohydrates (g)	Dietary Fiber (g)	Protein (g)	Vitamin A (IU)	Vitamin C (IU)	Calcium (mg)	Iron (mg)	Price ($)
Frozen Broccoli	73.8	0	0.8	68.2	13.6	8.5	8	5867.4	160.2	159	2.3	0.16
Carrots, Raw	23.7	0	0.1	19.2	5.6	1.6	0.6	15471	5.1	14.9	0.3	0.07
Celery, Raw	6.4	0	0.1	34.8	1.5	0.7	0.3	53.6	2.8	16	0.2	0.04
Frozen Corn	72.2	0	0.6	2.5	17.1	2	2.5	106.6	5.2	3.3	0.3	0.18
Lettuce, Iceberg, Raw	2.6	0	0	1.8	0.4	0.3	0.2	66	0.8	3.8	0.1	0.02
Peppers, Sweet, Raw	20	0	0.1	1.5	4.8	1.3	0.7	467.7	66.1	6.7	0.3	0.53
Potatoes, Baked	171.5	0	0.2	15.2	39.9	3.2	3.7	0	15.6	22.7	4.3	0.06
Tofu	88.2	0	5.5	8.1	2.2	1.4	9.4	98.6	0.1	121.8	6.2	0.31
Roasted Chicken	277.4	129.9	10.8	125.6	0	0	42.2	77.4	0	21.9	1.8	0.84



Resulting Optimized Diet

The Solution and Cost Breakdown by Food

	Food	Serving	Price
1	Frozen Broccoli	1.5	0.24
2	Potatoes, Baked	0.37	0.02
3	Tofu	1.63	0.5
4	Roasted Chicken	0.44	0.37
5	Wheat Bread	1.56	0.08
6	White Bread	10	0.6
7	Oatmeal Cookies	10	0.9

Showing 1 to 7 of 7 entries

The cost of this optimal diet is $2.7115 per day

Explore the results of the optimization process. View the optimal diet, cost breakdown, and other relevant information.

Refresh

Tableau Set-up and Basic Solution

Show 5 entries Search:

Iteration 0 - Tableau

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
1	-64.8117	64.8117	0	0	-0.7621	0.7621	-60.9184	60.9184	-11.4762	11.4762	-7.89
2	-0.0015	0.0015	0	0	0	0	-0.0012	0.0012	-0.0004	0.0004	-0.00
3	-6.3179	6.3179	0	0	-0.0997	0.0997	-34.7335	34.7335	-1.4806	1.4806	-0.69
4	-72.0367	72.0367	0	0	-0.5993	0.5993	-2.3677	2.3677	-17.0614	17.0614	-1.9
5	-2.4989	2.4989	0	0	0.0004	-0.0004	-1.7181	1.7181	-0.3761	0.3761	-0.29

Showing 1 to 5 of 21 entries Previous 1 2 3 4 5 Next

Iteration 0 - Basic Solution

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10
1	2242.3405	-1992.3405	300	0	64.9677	0.0323	2393.7948	6.2052	298.1902	1.8098

Showing 1 to 1 of 1 entries

Show 5 entries Search:

DEPENDENCIES OF THE PROGRAM

Polynomial Regression, Quadratic Spline Interpolation and Diet Problem Solver

Dependencies of the Program

External Libraries Utilized

- shiny: The core library for creating interactive web applications with R.
- shinydashboard: Enables the creation of dashboards within Shiny applications, providing a structured layout.
- shinyMatrix: A module for presenting matrices in Shiny applications.
- shinyjs: Allows customization of JavaScript behavior in Shiny applications.
- shinythemes: Permits the application of themes to the Shiny UI; Cerulean theme is used in this case.
- readxl: A library to read Excel files, utilized here for reading data from an Excel file.
- DT: Enables interactive data tables in Shiny applications.
- dplyr: Assists in data transformation and manipulation.

Source Code Files

- QuadraticSplineInterpolation.R: Contains functions and methods related to Quadratic Spline Interpolation.
- PolynomialRegression.R: Contains functions and methods related to Polynomial Regression.
- GaussJordanMethod.R: Contains functions related to the Gauss-Jordan method, likely used in the optimization process for the Diet Problem Solver.
- SimplexImplementation.R: Contains functions for setting up the tableau, probably related to optimization calculations.

Food List Data File

- DPS_fooditems.xlsx: An Excel file containing data regarding food items, nutrients, and constraints, used as input for the Diet Problem Solver.

Importance of these Dependencies

These dependencies collectively contribute to the functionalities of Polynomial Regression, Quadratic Spline Interpolation, and the Diet Problem Solver in the Shiny application. The libraries provide tools for creating the user interface, handling user interactions, and presenting data, while the source code files implement specific algorithms and methods for each numerical analysis task.

Conclusion

In conclusion, the provided R Shiny application serves as a versatile and user-friendly numerical methods tool, encompassing Polynomial Regression, Quadratic Spline Interpolation, and the Diet Problem Solver. Its significance lies in offering a seamless platform for users to upload data, perform complex mathematical analyses, visualize results, and optimize solutions across diverse domains. The app caters to a broad audience, including students, researchers, and professionals in fields such as statistics, mathematics, and nutritional planning. The Polynomial Regression functionality allows users to model relationships between variables, while Quadratic Spline Interpolation facilitates the estimation of values between data points. The Diet Problem Solver, employing the simplex method, aids in optimizing food item selection based on nutritional constraints. Altogether, this application empowers users to conduct numerical analysis and optimization tasks with ease, making it a valuable resource for both educational and practical purposes. Whether for academic exploration or real-world problem-solving, the R Shiny app provides an intuitive interface for users to delve into the intricacies of numerical methods.