CMSC 150 PYTHON PROJECT

An app that has a diet solver as its main features and generic solver as its additional feature. The diet solver involves the use of Simplex Method in minimization with mixed constraints. The generic solver on the other hand, has a feature to generate a polynomial regression function based on given data points and another feature that involves quadratic spline interpolation.

Diet Solver

The objective of this feature is to identify the most cost-effective and nutritious combination of foods that will fulfill all daily nutritional requirements. The combination of foods will be based upon the food options selected by the user. This problem is formulated as a linear program with the objective of minimizing cost under specified constraints and ensuring nutritional adequacy. These constraints control factors such as number of calories and amounts of vitamins, minerals, fats, sodium and cholesterol in the diet. Additionally, each food option is restricted to a range of 0-10 servings. The program employs simplex method set up as a dual problem to solve for the optimal combination of foods.
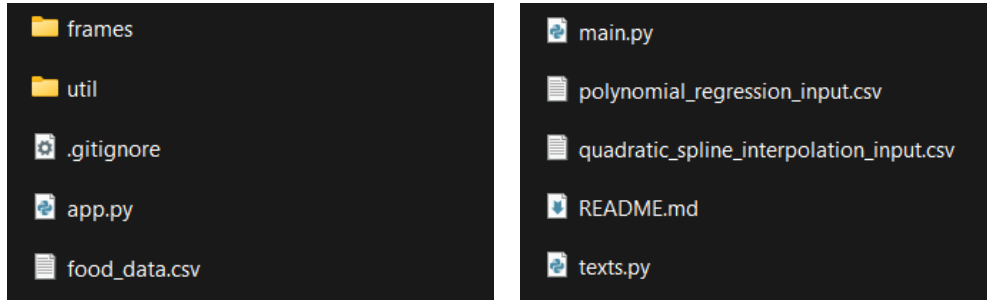
Polynomial Regression

Polynomial regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables. This calculator employs polynomial regression to generate precise polynomial equations based on user-provided data points. Users can input their datasets and specify the desired polynomial degree, allowing the calculator to determine the optimal polynomial equation that best fits the given data. The result is an accurate polynomial equation that can be utilized for predictive purposes. This tool is invaluable for tasks where a more complex relationship between variables needs to be captured, offering a higher degree of accuracy in modeling.

Quadratic Spline Interpolation

The quadratic spline interpolation calculator employs quadratic functions to interpolate data points seamlessly within a given range. By utilizing quadratic polynomials for each interval, the calculator ensures both continuity and differentiability at the connection points, facilitating precise curve fitting for the provided dataset. This method optimally captures the underlying trends in the data, offering an accurate representation of the relationship between variables. The result is a smooth, continuous curve that accurately reflects the nuances of the dataset.
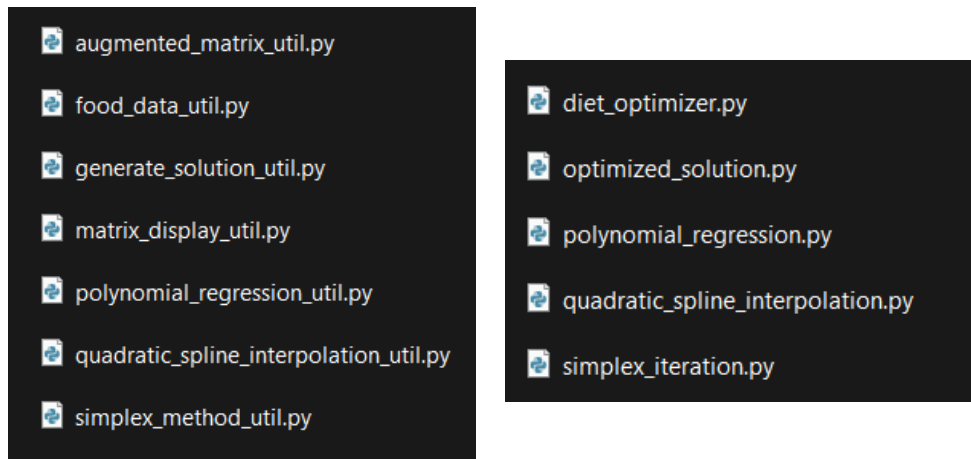
Downloading Resources

Upon downloading all resources for the project, it should contain all the following files:

📁 frames	🐍 main.py
📁 util	📄 polynomial_regression_input.csv
⚙️ .gitignore	📄 quadratic_spline_interpolation_input.csv
🐍 app.py	📥 README.md
📄 food_data.csv	🐍 texts.py

Utils and Frames Folders

The utils folders contains all the logic and necessary functions for various methods and return the necessary outputs for the user to see through an interface. The frames folders on the other hand contains all the UI for the program. It contains different pages and also handles the error prompts and calls the corresponding util function needed.

🐍 augmented_matrix_util.py	🐍 diet_optimizer.py
🐍 food_data_util.py	🐍 optimized_solution.py
🐍 generate_solution_util.py	🐍 polynomial_regression.py
🐍 matrix_display_util.py	🐍 quadratic_spline_interpolation.py
🐍 polynomial_regression_util.py	🐍 simplex_iteration.py
🐍 quadratic_spline_interpolation_util.py	
🐍 simplex_method_util.py	

Installing External Modules

Make sure you have Python and pip installed on your system before running these commands.

```
pip install tk
pip install ttkbootstrap
pip install numpy
```

If you're using a virtual environment, activate it before running the commands.

```
# Create a virtual environment
python -m venv myenv

# Activate the virtual environment (Windows)
myenv\Scripts\activate

# Activate the virtual environment (Unix or MacOS)
source myenv/bin/activate
```

Running the Program

Once you are in the correct directory, run your Python script using the python command followed by the script's filename. If you are using Python 3, you might need to use python3 instead:

```
# Navigate through file directory
cd path/to/your/script/directory

# Run the main python application
python main.py
```

Main Menu

Upon running the main application, we are greeted with the app overview and its available functions such as a diet solver, polynomial regression calculator and quadratic spline interpolation. Clicking the corresponding buttons will send the user to corresponding solver.

Diet Optimizer

Clicking the Diet Optimizer button will send user to the diet solver where they have the option to select foods. The program has a built-in search function to make selection easier in addition to the default checkboxes.

Clicking the *SEE NUTRIENTS* button will show a pop-up window of all the food data with corresponding nutritional values and its price per serving.

Below is the list of foods and its corresponding cost and nutritional value per serving

Foods	Costs	Serving	Calories	Cholesterol n	Fat g	Sodium mg	Carbs g	Fiber g	Protein g	Vit A	Vit C	Calcium mg	Iron mg
Frozen Broccoli	0.16	10.00 Oz Pkg	73.8	0.0	0.8	68.2	13.6	8.5	8.0	5867.4	160.2	159.0	2.3
Carrots,Raw	0.07	0.50 Cup Shredd	23.7	0.0	0.1	19.2	5.6	1.6	0.6	15471.0	5.1	14.9	0.3
Celery, Raw	0.04	1.00 Stalk	6.4	0.0	0.1	34.8	1.5	0.7	0.3	53.6	2.8	16.0	0.2
Frozen Corn	0.18	0.50 Cup	72.2	0.0	0.6	2.5	17.1	2.0	2.5	106.6	5.2	3.3	0.3
Lettuce,Iceber g,Raw	0.02	1.00 Leaf	2.6	0.0	0.0	1.8	0.4	0.3	0.2	66.0	0.8	3.8	0.1
Peppers, Sweet, Raw	0.53	1.00 Pepper	20.0	0.0	0.1	1.5	4.8	1.3	0.7	467.7	66.1	6.7	0.3
Potatoes, Baked	0.06	0.50 Cup	171.5	0.0	0.2	15.2	39.9	3.2	3.7	0.0	15.6	22.7	4.3
Tofu	0.31	0.25 Block	88.2	0.0	5.5	8.1	2.2	1.4	9.4	98.6	0.1	121.8	6.2
Roasted Chicken	0.84	1.00 Lb	277.4	129.9	10.8	125.6	0.0	0.0	42.2	77.4	0.0	21.9	1.8
Spaghetti W/ Sauce	0.78	1.50 Cup	358.2	0.0	12.3	1237.1	58.3	11.6	8.2	3055.2	27.9	80.2	2.3
Tomato,Red,R ipe,Raw	0.27	1.00 Tomato, 2-	25.8	0.0	0.4	11.1	5.7	1.4	1.0	766.3	23.5	6.2	0.6
Apple,Raw,W/ Skin	0.24	1.00 Fruit,3/Lb,W	81.4	0.0	0.5	0.0	21.0	3.7	0.3	73.1	7.9	9.7	0.2
Banana	0.15	1.00 Fruit,Wo/Sk	104.9	0.0	0.5	1.1	26.7	2.7	1.2	92.3	10.4	6.8	0.4
Grapes	0.32	10.00 Fruits,Wo/I	15.1	0.0	0.1	0.5	4.1	0.2	0.2	24.0	1.0	3.4	0.1
Kiwifruit,Raw, Fresh	0.49	1.00 Med Frt,Wo,	46.4	0.0	0.3	3.8	11.3	2.6	0.8	133.0	74.5	19.8	0.3

The program also has a *SELECT ALL* function if user chooses to have a wide variation of foods and for easier testing of the program's simplex method set up as a dual problem.

Diet Optimizer

Use the food search bar function or manually tick checkboxes to select desired foods.

[Search desired foods] [Add]

✓ Frozen Broccoli	✓ Grapes	✓ Skim Milk	✓ Oatmeal	✓ Popcorn,Air- Popped
✓ Carrots,Raw	✓ Kiwifruit,Raw, Fresh	✓ Poached Eggs	✓ Malt-O- Meal,Choc	✓ Potato Chips,Bbqflvr
✓ Celery, Raw	✓ Oranges	✓ Scrambled Eggs	✓ Pizza W/Pepperoni	✓ Pretzels
✓ Frozen Corn	✓ Bagels	✓ Bologna,Turke y	✓ Taco	✓ Tortilla Chip
✓ Lettuce,Iceber g,Raw	✓ Wheat Bread	✓ Frankfurter, Beef	✓ Hamburger W/Toppings	✓ Chicknoodl Soup
✓ Peppers, Sweet, Raw	✓ White Bread	✓ Ham,Sliced,Ex tralean	✓ Hotdog, Plain	✓ Splt Pea&Hamsoup
✓ Potatoes, Baked	✓ Oatmeal Cookies	✓ Kielbasa,Prk	✓ Couscous	✓ Vegetbeef Soup
✓ Tofu	✓ Apple Pie	✓ Cap'N Crunch	✓ White Rice	✓ Neweng Clamchwd
✓ Roasted Chicken	✓ Chocolate Chip Cookies	✓ Cheerios	✓ Macaroni,Ckd	✓ Tomato Soup
✓ Spaghetti W/ Sauce	✓ Butter,Regular	✓ Corn Flks, Kellogg'S	✓ Peanut Butter	✓ New E Clamchwd,W/ Mlk
✓ Tomato,Red,R ipe,Raw	✓ Cheddar Cheese	✓ Raisin Brn, Kellg'S	✓ Pork	✓ Crm Mshrm Soup,W/Mlk
✓ Apple,Raw,W/ Skin	✓ 3.3% Fat,Whole Milk	✓ Rice Krispies	✓ Sardines in Oil	✓ Beanbacn Soup,W/Watr
✓ Banana	✓ 2% Lowfat Milk	✓ Special K	✓ White Tuna in Water	

[Back] [See Nutrients Table] [Select All] [Generate] [Clear Selection]

Upon clicking the *GENERATE* button the program will generate the optimal combination of foods that would meet the daily nutritional requirements at the cheapest cost. The *CLEAR SELECTION* enables clear all previous selection.

Optimized Food Combination

This is the most cost efficient combination of foods based on your selection that will meet your minimum nutrient daily needs.

[Back] [See Simplex Iterations]

Food	Serving	Cost
Carrots,Raw	0.24	$ 0.02
Potatoes, Baked	3.54	$ 0.21
Skim Milk	2.17	$ 0.28
Peanut Butter	3.60	$ 0.25
Popcorn,Air- Popped	4.82	$ 0.19
Total Cost	~	$ 0.96

Upon clicking the *GENERATE* button without a food selected proper error prompts would be display and the *SEE SIMPLEX ITERATION* button would be disable as there is not food selection to optimize

Optimized Food Combination

Given the list of selected foods, there is no way to meet the daily minimum nutrient requirements. Try choosing more foods or vary your selection.

Warning: No Food Selected

Back   See Simplex Iterations

However, upon choosing a variation of foods with feasible solution, users can choose to see each simplex iteration with its corresponding basic solution. They can select the specific iteration they want to see and generate the iteration by clicking the *GENERATE ITERATION* BUTTON

Simplex Iterations

Choose specific iteration count to display below the matrix for that iteration of the simplex method set up as a dual problem for solving the optimal food combination that would meet minimum daily nutrient requirements.

Back   Generate Iteration   5

S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
0.0	-32.16	0.0	-111.0	0.0	9.0	1.74	0.0	-33.61	0.0	-7.21	0.0	32.16	0.0	111.06	0.0	-9.0	-1.74	0.0	33.61
0.0	-31.55	0.0	-672.7	0.0	63.18	7.94	0.0	-226.4	0.0	-43.16	0.0	31.55	0.0	672.71	0.0	-63.18	-7.94	0.0	226.4
0.0	-0.44	1.0	47.08	0.0	-6.49	-2.68	0.0	23.49	0.0	4.46	0.0	0.44	-1.0	-47.08	0.0	6.49	2.68	0.0	-23.49
0.0	-0.7	0.0	-57.89	0.0	-9.84	-1.82	0.0	33.23	0.0	8.29	0.0	0.7	0.0	57.89	0.0	9.84	1.82	0.0	-33.23
0.0	0.08	0.0	-481.0	0.0	2.86	0.68	0.0	2.0	0.0	-0.03	0.0	-0.08	0.0	481.02	0.0	-2.86	-0.68	0.0	-2.0
0.0	-0.01	0.0	-21.74	0.0	-6.64	0.35	0.0	30.2	0.0	5.99	0.0	0.01	0.0	21.74	0.0	6.64	-0.35	0.0	-30.2
0.0	-11.08	0.0	-1895.	0.0	16.24	3.56	0.0	-49.83	0.0	-10.26	0.0	11.08	0.0	1895.5	0.0	-16.24	-3.56	0.0	49.83
0.0	-5.7	0.0	-1022.	0.0	18.86	2.89	0.0	-68.55	0.0	-13.01	0.0	5.7	0.0	1022.6	0.0	-18.86	-2.89	0.0	68.55
0.0	-8.36	0.0	-1984.	0.0	19.69	2.84	0.0	-73.91	0.0	-14.71	0.0	8.36	0.0	1984.4	0.0	-19.69	-2.84	0.0	73.91
0.0	-7.85	0.0	-1882.	0.0	17.98	3.16	0.0	-60.4	0.0	-12.6	0.0	7.85	0.0	1882.8	0.0	-17.98	-3.16	0.0	60.4
0.0	-0.29	0.0	-1660.	0.0	-3.66	-1.99	0.0	-99.74	0.0	3.89	0.0	0.29	0.0	1660.2	0.0	3.66	1.99	0.0	99.74
0.0	-19.32	0.0	-889.8	0.0	6.12	2.05	0.0	-21.85	0.0	-4.69	0.0	19.32	0.0	889.86	0.0	-6.12	-2.05	0.0	21.85
0.0	-17.93	0.0	-827.7	0.0	-6.98	1.22	0.0	30.45	0.0	5.96	0.0	17.93	0.0	827.77	0.0	6.98	-1.22	0.0	-30.45
0.0	-1.12	0.0	-897.9	0.0	0.14	1.39	0.0	-17.26	0.0	-4.27	0.0	1.12	0.0	897.96	0.0	-0.14	-1.39	0.0	17.26
250.0	290.46	0.0	1502.7	0.0	59.98	24.41	45000.	19938.	800.0	8.45	0.0	9.54	65.0	897.22	300.0	15.02	25.59	0.0	11.71

5	x46	x47	x48	x49	x50	x51	x52	x53	x54	x55	x56	x57	x58	x59	x60	x61	x62	x63	x64	z
	0.0	0.0	0.0	3.6	0.0	0.0	0.0	4.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.96

This also includes proper error prompts if invalid iteration count was inputted by the user or if the user did not specify the iteration count upon clicking the *GENERATE* button

Simplex Iterations

Choose specific iteration count to display below the matrix for that iteration of the simplex method set up as a dual problem for solving the optimal food combination that would meet minimum daily nutrient requirements.

Back   Generate Iteration

Select iteration count first

CMSC 150 Numerical and Symbolic Computation
Franz Christian D. Morelos - Project Manual

Upon navigating to the polynomial regression calculator through the main menu, the user may have the option of manually typing each data points following the format specified. A *RESET* button is also included for user to easily try new estimates and datapoints.

If data set is large, there is also an option of uploading a csv file following the example format that can be seen by clicking the *SEE EXAMPLE* button. Upon filling in the parameter such as degree and estimate, the program will generate a polynomial regression function and the estimate at that point.

CSV File format example
This can be accessed
Upon clicking the see
Example button

Upon navigating to the quadratic spline interpolation page, similar to the polynomial regression page, the user may also manually type each datapoints or upload a csv file following the specified format. The program will then generate each function for each interval and estimate at a specific point, this is upon clicking the *CALCULATE* button. Ther is also a *RESET* button to make testing eaiser.