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1 EEP 153 Project 2: Group James Lind

1.0.1 Minimum Cost Diet

Topic: Investigate the minimum cost diet for Berkeley students living in dormitories who rely on meal plans and Trader Joe's frozen food for daily nutrient intake.

Objective: 1. Find out minimum requirement of daily nutrient intake for college students 2. Collect data from Trader Joe's website and create a dataframe with 50 unique frozen foods and their respective price, quantities and nutrients 3. Solve the minimum cost diet problem for Berkeley dormitories students; create a frozen food receipt and analyze its limitations

6. [[B] Recipe for the minimum cost meal]

7. [[C] Sensitivity of Solution]

1.0.2 Libraries Import

```
[1]: !pip install -r requirements.txt
      !pip install eep153_tools
```

Requirement already satisfied: pint>=0.18 in /opt/conda/lib/python3.9/site-packages (from -r requirements.txt (line 3)) (0.20.1)

Requirement already satisfied: requests>=2.26.0 in /opt/conda/lib/python3.9/site-packages (from -r requirements.txt (line 6)) (2.26.0)

Requirement already satisfied: python-gnupg in /opt/conda/lib/python3.9/site-packages (from -r requirements.txt (line 8)) (0.5.0)

Requirement already satisfied: eep153_tools in /opt/conda/lib/python3.9/site-packages (from -r requirements.txt (line 10)) (0.11)

Requirement already satisfied: fooddatacentral in /opt/conda/lib/python3.9/site-packages (from -r requirements.txt (line 12)) (1.0.9)

Requirement already satisfied: charset-normalizer~2.0.0 in /opt/conda/lib/python3.9/site-packages (from requests>=2.26.0->-r requirements.txt (line 6)) (2.0.0)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/python3.9/site-packages (from requests>=2.26.0->-r requirements.txt (line 6)) (2021.10.8)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/lib/python3.9/site-packages (from requests>=2.26.0->-r requirements.txt (line 6)) (3.1)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/lib/python3.9/site-packages (from requests>=2.26.0->requirements.txt (line 6)) (1.26.7)
Requirement already satisfied: eep153_tools in /opt/conda/lib/python3.9/site-packages (0.11)

```
[2]: import pandas as pd
import numpy as np
import fooddatacentral as fdc
import regex as re
import matplotlib.pyplot as plt
from eep153_tools.sheets import read_sheets

from scipy.optimize import linprog as lp
import warnings
apikey = "erxlvhinjtIFU2KUGhLfPyBDw8qgaK8FKILj45fk"
```

1.0.3 [A] Description of Population of Interest

We are focusing on undergraduate Berkeley students who are living in the dorms and on a basic meal plan. We assume that they are on a diet with only meal plans and Trader Joe's frozen food.

1.0.4 [A] Dietary Reference Intakes

A function that takes in characteristics of a person (age, sex) and return a pandas.Series of Dietary Reference Intakes of nutrients appropriate for Berkeley undergraduate students.

```
[3]: diet_minimum = pd.read_csv('diet_minimums.txt').set_index('Nutrition').iloc[:,2:
    ↪]
diet_maximum = pd.read_csv('diet_maximums.csv').set_index('Nutrition').iloc[:,1:
    ↪]
diet_maximum
```

```
[3]:
```

	C 1-3	F 4-8	M 4-8	F 9-13	M 9-13	F 14-18	M 14-18	F 19-30	\
Nutrition									
Sodium, Na	1500	1900	1900	2200	2200	2300	2300	2300	
Energy	2500	2500	2500	2800	3000	3100	3100	3100	

	M 19-30	F 31-50	M 31-50	F 51+	M 51+
Nutrition					
Sodium, Na	2300	2300	2300	2300	2300
Energy	3100	3100	3100	3100	3100

```
[4]: diet_minimum
```

```
[4]:
```

	C 1-3	F 4-8	M 4-8	F 9-13	M 9-13	\
Nutrition						
Energy	1000.0	1200.0	1400.0	1600.0	1800.0	

Protein	13.0	19.0	19.0	34.0	34.0
Fiber, total dietary	14.0	16.8	19.6	22.4	25.2
Folate, DFE	150.0	200.0	200.0	300.0	300.0
Calcium, Ca	700.0	1000.0	1000.0	1300.0	1300.0
Carbohydrate, by difference	130.0	130.0	130.0	130.0	130.0
Iron, Fe	7.0	10.0	10.0	8.0	8.0
Magnesium, Mg	80.0	130.0	130.0	240.0	240.0
Niacin	6.0	8.0	8.0	12.0	12.0
Phosphorus, P	460.0	500.0	500.0	1250.0	1250.0
Potassium, K	3000.0	3800.0	3800.0	4500.0	4500.0
Riboflavin	0.5	0.6	0.6	0.9	0.9
Thiamin	0.5	0.6	0.6	0.9	0.9
Vitamin A, RAE	300.0	400.0	400.0	600.0	600.0
Vitamin B-12	0.9	1.2	1.2	1.8	1.8
Vitamin B-6	0.5	0.6	0.6	1.0	1.0
Vitamin C, total ascorbic acid	15.0	25.0	25.0	45.0	45.0
Vitamin E (alpha-tocopherol)	6.0	7.0	7.0	11.0	11.0
Vitamin K (phylloquinone)	30.0	55.0	55.0	60.0	60.0
Zinc, Zn	3.0	5.0	5.0	8.0	8.0

	F 14-18	M 14-18	F 19-30	M 19-30	F 31-50 \
Nutrition					
Energy	1800.0	2200.0	2000.0	2400.0	1800.0
Protein	46.0	52.0	46.0	56.0	46.0
Fiber, total dietary	25.2	30.8	28.0	33.6	25.2
Folate, DFE	400.0	400.0	400.0	400.0	400.0
Calcium, Ca	1300.0	1300.0	1000.0	1000.0	1000.0
Carbohydrate, by difference	130.0	130.0	130.0	130.0	130.0
Iron, Fe	15.0	11.0	18.0	8.0	18.0
Magnesium, Mg	360.0	410.0	310.0	400.0	320.0
Niacin	14.0	16.0	14.0	16.0	14.0
Phosphorus, P	1250.0	1250.0	700.0	700.0	700.0
Potassium, K	4700.0	4700.0	4700.0	4700.0	4700.0
Riboflavin	1.0	1.3	1.1	1.3	1.1
Thiamin	1.0	1.2	1.1	1.2	1.1
Vitamin A, RAE	700.0	900.0	700.0	900.0	700.0
Vitamin B-12	2.4	2.4	2.4	2.4	2.4
Vitamin B-6	1.2	1.3	1.3	1.3	1.3
Vitamin C, total ascorbic acid	65.0	75.0	75.0	90.0	75.0
Vitamin E (alpha-tocopherol)	15.0	15.0	15.0	15.0	15.0
Vitamin K (phylloquinone)	75.0	75.0	90.0	120.0	90.0
Zinc, Zn	9.0	11.0	8.0	11.0	8.0

	M 31-50	F 51+	M 51+
Nutrition			
Energy	2200.0	1600.0	2000.0
Protein	56.0	46.0	56.0

Fiber, total dietary	30.8	22.4	28.0
Folate, DFE	400.0	400.0	400.0
Calcium, Ca	1000.0	1200.0	1000.0
Carbohydrate, by difference	130.0	130.0	130.0
Iron, Fe	8.0	8.0	8.0
Magnesium, Mg	420.0	320.0	420.0
Niacin	16.0	14.0	16.0
Phosphorus, P	700.0	700.0	700.0
Potassium, K	4700.0	4700.0	4700.0
Riboflavin	1.3	1.1	1.3
Thiamin	1.2	1.1	1.2
Vitamin A, RAE	900.0	700.0	900.0
Vitamin B-12	2.4	2.4	2.4
Vitamin B-6	1.3	1.5	1.7
Vitamin C, total ascorbic acid	90.0	75.0	90.0
Vitamin E (alpha-tocopherol)	15.0	15.0	15.0
Vitamin K (phylloquinone)	120.0	90.0	120.0
Zinc, Zn	11.0	8.0	11.0

```
[5]: transformed_age_sex_groups = []
transformed_age_sex_groups += [diet_minimum.columns[0]]
for col in diet_minimum.columns[1:]:
    element = []
    if col[0] == 'F':
        element += ['female']
    else:
        element += ['male']
    ages = re.findall('[0-9]+', col)
    if len(ages) == 2:
        element += range(int(ages[0]),int(ages[1])+1)
    else:
        element += range(int(ages[0]),101)
    transformed_age_sex_groups += [element]
```

```
[6]: def nutrient_intake(age, sex, data):
    if age >= 1 and age <= 3:
        return data.iloc[:,0]
    for i in range(len(transformed_age_sex_groups)):
        if (sex.lower() in transformed_age_sex_groups[i]) and (age in
↳ transformed_age_sex_groups[i]):
            return data.iloc[:,i]
```

Example: the minimum nutrient intake for a 90-year-old female

```
[7]: female_90 = nutrient_intake(90, 'female', diet_minimum)
female_90
```

```
[7]: Nutrition
      Energy                1600.0
      Protein                46.0
      Fiber, total dietary   22.4
      Folate, DFE           400.0
      Calcium, Ca           1200.0
      Carbohydrate, by difference 130.0
      Iron, Fe               8.0
      Magnesium, Mg         320.0
      Niacin                 14.0
      Phosphorus, P         700.0
      Potassium, K          4700.0
      Riboflavin             1.1
      Thiamin                1.1
      Vitamin A, RAE         700.0
      Vitamin B-12           2.4
      Vitamin B-6            1.5
      Vitamin C, total ascorbic acid 75.0
      Vitamin E (alpha-tocopherol) 15.0
      Vitamin K (phylloquinone) 90.0
      Zinc, Zn               8.0
      Name: F 51+, dtype: float64
```

Example: the maximum nutrient intake for a 3-year-old male

```
[8]: male_3 = nutrient_intake(3, 'male', diet_maximum)
      male_3
```

```
[8]: Nutrition
      Sodium, Na    1500
      Energy        2500
      Name: C 1-3, dtype: int64
```

1.0.5 [A] Data on prices for different foods

Self-collected data on Trader Joe's frozen food

```
[9]: food_data = pd.read_csv("Trader Joes Data.csv").set_index("Food Item")
      food_data.fillna(0)
```

```
[9]:
```

Food Item	Price of Item (USD) \
Vegetable Fried Rice	2.99
Korean Beefless Bulgogi	4.49
Cheese & Green Chile Tamales	3.79
Stir Fried Garlicky Cabbage	3.49
Vegetarian Meatless Cheeseburger Pizza	5.99
Roasted Garlic & Pesto Pizza with Deep Fried Crust	5.99

Chickenless Crispy Tenders	3.79
Bulgogi Beef Fried Rice with Kimchi	5.49
Bulgur Pilaf with Butternut Squash & Feta Cheese	3.49
Chicken Burrito Bowl	3.49
Italian Tomato & Red Onion Focaccia	3.99
Cuban Style Citrus Garlic Bowl	3.99
Hashbrowns	2.49
Pão D'Água Portuguese Rolls	2.29
Layered Beef Tostada	3.99
Mini Chicken Tacos	5.99
Mini Beef Tacos	5.99
Hatch Chile Mac & Cheese	2.99
Tteok Bok Ki	3.99
Jamaican Style Beef Patties	4.49
Kalua Pork Spring Rolls	4.79
Beef Birria	7.99
BBQ Teriyaki Chicken	5.99
Italian Style Meatballs	4.99
Premium Salmon Burgers	7.49
Mandarin Orange Chicken	4.99
Egg Frittata	3.49
Mexican Style Roasted Corn	3.79
Mixed Mushroom & Spinach Quiche	2.69
BBQ Teriyaki Chicken	5.99
Eggwich Breadless Breakfast Sandwhich	4.99
Southwest Style Chicken Quesadillas	4.29
Kimchi & Tofu Soup	3.49
Vegetable Pad Thai	3.49
Spicy Thai Shrimp Fried Rice	5.99
Carne Asada Burritos	4.99
Vegan Pasta Bolognese Bowl	3.49
Cheese Filled Fiocchetti with Pink Sauce	3.99
Quiche Lorraine	5.49
Beef Pho	3.49
Cauliflower Gnocchi	2.99
Gluten Free Mac & Cheese	3.69
Steamed Pork & Ginger Soup Dumplings	3.49
Sriracha Shrimp Bowl	3.49
Chicken-less Mandarin Orange Morsels	3.79
Pizza Parlano	4.99
Outside-In Stuffed Gnocchi	3.69
Cuban Style Citrus Garlic Bowl	3.99
Honey Walnut Shrimp	6.99
Chipotle Vegetable Quesadillas	3.69

Number of Servings \

Food Item

Vegetable Fried Rice	3.0
Korean Beefless Bulgogi	3.0
Cheese & Green Chile Tamales	2.0
Stir Fried Garlicky Cabbage	2.0
Vegetarian Meatless Cheeseburger Pizza	3.0
Roasted Garlic & Pesto Pizza with Deep Fried Crust	3.0
Chickenless Crispy Tenders	3.0
Bulgogi Beef Fried Rice with Kimchi	1.0
Bulgur Pilaf with Butternut Squash & Feta Cheese	3.5
Chicken Burrito Bowl	1.0
Italian Tomato & Red Onion Focaccia	3.0
Cuban Style Citrus Garlic Bowl	1.0
Hashbrowns	10.0
Pão D'Água Portuguese Rolls	4.0
Layered Beef Tostada	1.0
Mini Chicken Tacos	6.0
Mini Beef Tacos	6.0
Hatch Chile Mac & Cheese	2.0
Tteok Bok Ki	1.0
Jamaican Style Beef Patties	1.0
Kalua Pork Spring Rolls	2.0
Beef Birria	2.0
BBQ Teriyaki Chicken	4.0
Italian Style Meatballs	6.0
Premium Salmon Burgers	4.0
Mandarin Orange Chicken	5.0
Egg Frittata	1.0
Mexican Style Roasted Corn	3.5
Mixed Mushroom & Spinach Quiche	1.0
BBQ Teriyaki Chicken	4.0
Eggwich Breadless Breakfast Sandwhich	2.0
Southwest Style Chicken Quesadillas	2.0
Kimchi & Tofu Soup	1.0
Vegetable Pad Thai	1.0
Spicy Thai Shrimp Fried Rice	3.0
Carne Asada Burritos	2.0
Vegan Pasta Bolognese Bowl	1.0
Cheese Filled Fiocchetti with Pink Sauce	3.0
Quiche Lorraine	3.0
Beef Pho	1.0
Cauliflower Gnocchi	2.5
Gluten Free Mac & Cheese	2.0
Steamed Pork & Ginger Soup Dumplings	1.0
Sriracha Shrimp Bowl	1.0
Chicken-less Mandarin Orange Morsels	2.0
Pizza Parlano	4.0
Outside-In Stuffed Gnocchi	3.5

Cuban Style Citrus Garlic Bowl	1.0
Honey Walnut Shrimp	2.0
Chipotle Vegetable Quesadillas	2.0

Food Item	Energy	Total Fat (g) \
Vegetable Fried Rice	230	2.5
Korean Beefless Bulgogi	230	11.0
Cheese & Green Chile Tamales	290	16.0
Stir Fried Garlicky Cabbage	130	9.0
Vegetarian Meatless Cheeseburger Pizza	340	15.0
Roasted Garlic & Pesto Pizza with Deep Fried Crust	430	20.0
Chickenless Crispy Tenders	170	7.0
Bulgogi Beef Fried Rice with Kimchi	400	10.0
Bulgur Pilaf with Butternut Squash & Feta Cheese	200	10.0
Chicken Burrito Bowl	370	10.0
Italian Tomato & Red Onion Focaccia	280	7.0
Cuban Style Citrus Garlic Bowl	400	18.0
Hashbrowns	120	6.0
Pão D'Água Portuguese Rolls	160	0.5
Layered Beef Tostada	460	23.0
Mini Chicken Tacos	260	13.0
Mini Beef Tacos	270	14.0
Hatch Chile Mac & Cheese	260	10.0
Tteok Bok Ki	280	1.5
Jamaican Style Beef Patties	440	22.0
Kalua Pork Spring Rolls	290	14.0
Beef Birria	280	15.0
BBQ Teriyaki Chicken	240	9.0
Italian Style Meatballs	240	20.0
Premium Salmon Burgers	100	3.0
Mandarin Orange Chicken	320	16.0
Egg Frittata	270	15.0
Mexican Style Roasted Corn	180	8.0
Mixed Mushroom & Spinach Quiche	420	26.0
BBQ Teriyaki Chicken	240	9.0
Eggwich Breadless Breakfast Sandwhich	190	12.0
Southwest Style Chicken Quesadillas	410	19.0
Kimchi & Tofu Soup	260	6.0
Vegetable Pad Thai	360	11.0
Spicy Thai Shrimp Fried Rice	220	5.0
Carne Asada Burritos	490	19.0
Vegan Pasta Bolognese Bowl	430	10.0
Cheese Filled Fiocchetti with Pink Sauce	290	17.0
Quiche Lorraine	340	22.0
Beef Pho	220	4.5
Cauliflower Gnocchi	140	3.0

Gluten Free Mac & Cheese	300	10.0
Steamed Pork & Ginger Soup Dumplings	270	10.0
Sriracha Shrimp Bowl	320	8.0
Chicken-less Mandarin Orange Morsels	270	8.0
Pizza Parlano	330	16.0
Outside-In Stuffed Gnocchi	180	3.5
Cuban Style Citrus Garlic Bowl	400	18.0
Honey Walnut Shrimp	500	28.0
Chipotle Vegetable Quesadillas	360	13.0

Food Item	Saturated Fat (g) \
Vegetable Fried Rice	0.0
Korean Beefless Bulgogi	2.0
Cheese & Green Chile Tamales	6.0
Stir Fried Garlicky Cabbage	2.0
Vegetarian Meatless Cheeseburger Pizza	5.0
Roasted Garlic & Pesto Pizza with Deep Fried Crust	9.0
Chickenless Crispy Tenders	0.5
Bulgogi Beef Fried Rice with Kimchi	1.5
Bulgur Pilaf with Butternut Squash & Feta Cheese	3.0
Chicken Burrito Bowl	4.5
Italian Tomato & Red Onion Focaccia	1.0
Cuban Style Citrus Garlic Bowl	2.0
Hashbrowns	1.0
Pão D'Água Portuguese Rolls	0.0
Layered Beef Tostada	12.0
Mini Chicken Tacos	2.5
Mini Beef Tacos	3.0
Hatch Chile Mac & Cheese	6.0
Tteok Bok Ki	0.0
Jamaican Style Beef Patties	10.0
Kalua Pork Spring Rolls	3.0
Beef Birria	5.0
BBQ Teriyaki Chicken	2.0
Italian Style Meatballs	8.0
Premium Salmon Burgers	0.5
Mandarin Orange Chicken	3.5
Egg Frittata	10.0
Mexican Style Roasted Corn	2.0
Mixed Mushroom & Spinach Quiche	17.0
BBQ Teriyaki Chicken	2.0
Eggwich Breadless Breakfast Sandwhich	5.0
Southwest Style Chicken Quesadillas	11.0
Kimchi & Tofu Soup	1.0
Vegetable Pad Thai	4.5
Spicy Thai Shrimp Fried Rice	2.0

Carne Asada Burritos	5.0
Vegan Pasta Bolognese Bowl	1.5
Cheese Filled Fiocchetti with Pink Sauce	10.0
Quiche Lorraine	12.0
Beef Pho	1.0
Cauliflower Gnocchi	0.5
Gluten Free Mac & Cheese	5.0
Steamed Pork & Ginger Soup Dumplings	3.0
Sriracha Shrimp Bowl	1.5
Chicken-less Mandarin Orange Morsels	0.5
Pizza Parlano	6.0
Outside-In Stuffed Gnocchi	2.0
Cuban Style Citrus Garlic Bowl	2.0
Honey Walnut Shrimp	8.0
Chipotle Vegetable Quesadillas	5.0

Food Item	Trans Fat (g) \
Vegetable Fried Rice	0.0
Korean Beefless Bulgogi	0.0
Cheese & Green Chile Tamales	0.0
Stir Fried Garlicky Cabbage	0.0
Vegetarian Meatless Cheeseburger Pizza	0.0
Roasted Garlic & Pesto Pizza with Deep Fried Crust	0.0
Chickenless Crispy Tenders	0.0
Bulgogi Beef Fried Rice with Kimchi	0.0
Bulgur Pilaf with Butternut Squash & Feta Cheese	0.0
Chicken Burrito Bowl	0.0
Italian Tomato & Red Onion Focaccia	0.0
Cuban Style Citrus Garlic Bowl	0.0
Hashbrowns	0.0
Pão D'Água Portuguese Rolls	0.0
Layered Beef Tostada	0.5
Mini Chicken Tacos	0.0
Mini Beef Tacos	0.0
Hatch Chile Mac & Cheese	0.0
Tteok Bok Ki	0.0
Jamaican Style Beef Patties	0.5
Kalua Pork Spring Rolls	0.0
Beef Birria	0.0
BBQ Teriyaki Chicken	0.0
Italian Style Meatballs	1.0
Premium Salmon Burgers	0.0
Mandarin Orange Chicken	0.0
Egg Frittata	0.0
Mexican Style Roasted Corn	0.0
Mixed Mushroom & Spinach Quiche	0.0

BBQ Teriyaki Chicken	0.0
Eggwich Breadless Breakfast Sandwhich	0.0
Southwest Style Chicken Quesadillas	0.0
Kimchi & Tofu Soup	0.0
Vegetable Pad Thai	0.0
Spicy Thai Shrimp Fried Rice	0.0
Carne Asada Burritos	0.0
Vegan Pasta Bolognese Bowl	0.0
Cheese Filled Fiocchetti with Pink Sauce	0.0
Quiche Lorraine	0.5
Beef Pho	0.0
Cauliflower Gnocchi	0.0
Gluten Free Mac & Cheese	0.0
Steamed Pork & Ginger Soup Dumplings	0.0
Sriracha Shrimp Bowl	0.0
Chicken-less Mandarin Orange Morsels	0.0
Pizza Parlano	0.0
Outside-In Stuffed Gnocchi	0.0
Cuban Style Citrus Garlic Bowl	0.0
Honey Walnut Shrimp	0.0
Chipotle Vegetable Quesadillas	0.0

Food Item	Cholestrol (mg) \
Vegetable Fried Rice	0
Korean Beefless Bulgogi	0
Cheese & Green Chile Tamales	20
Stir Fried Garlicky Cabbage	0
Vegetarian Meatless Cheeseburger Pizza	20
Roasted Garlic & Pesto Pizza with Deep Fried Crust	25
Chickenless Crispy Tenders	0
Bulgogi Beef Fried Rice with Kimchi	20
Bulgur Pilaf with Butternut Squash & Feta Cheese	10
Chicken Burrito Bowl	55
Italian Tomato & Red Onion Focaccia	0
Cuban Style Citrus Garlic Bowl	45
Hashbrowns	0
Pão D'Água Portuguese Rolls	0
Layered Beef Tostada	70
Mini Chicken Tacos	20
Mini Beef Tacos	15
Hatch Chile Mac & Cheese	30
Tteok Bok Ki	0
Jamaican Style Beef Patties	30
Kalua Pork Spring Rolls	15
Beef Birria	105
BBQ Teriyaki Chicken	135

Italian Style Meatballs	65
Premium Salmon Burgers	20
Mandarin Orange Chicken	95
Egg Frittata	135
Mexican Style Roasted Corn	15
Mixed Mushroom & Spinach Quiche	205
BBQ Teriyaki Chicken	135
Eggwich Breadless Breakfast Sandwhich	265
Southwest Style Chicken Quesadillas	55
Kimchi & Tofu Soup	0
Vegetable Pad Thai	0
Spicy Thai Shrimp Fried Rice	15
Carne Asada Burritos	50
Vegan Pasta Bolognese Bowl	0
Cheese Filled Fiocchetti with Pink Sauce	65
Quiche Lorraine	200
Beef Pho	25
Cauliflower Gnocchi	0
Gluten Free Mac & Cheese	30
Steamed Pork & Ginger Soup Dumplings	40
Sriracha Shrimp Bowl	35
Chicken-less Mandarin Orange Morsels	0
Pizza Parlano	30
Outside-In Stuffed Gnocchi	30
Cuban Style Citrus Garlic Bowl	45
Honey Walnut Shrimp	125
Chipotle Vegetable Quesadillas	30

	Sodium, Na \
Food Item	
Vegetable Fried Rice	510
Korean Beefless Bulgogi	580
Cheese & Green Chile Tamales	610
Stir Fried Garlicky Cabbage	620
Vegetarian Meatless Cheeseburger Pizza	790
Roasted Garlic & Pesto Pizza with Deep Fried Crust	900
Chickenless Crispy Tenders	380
Bulgogi Beef Fried Rice with Kimchi	1150
Bulgur Pilaf with Butternut Squash & Feta Cheese	380
Chicken Burrito Bowl	630
Italian Tomato & Red Onion Focaccia	500
Cuban Style Citrus Garlic Bowl	540
Hashbrowns	250
Pão D'Água Portuguese Rolls	230
Layered Beef Tostada	830
Mini Chicken Tacos	430
Mini Beef Tacos	460

Hatch Chile Mac & Cheese	430
Tteok Bok Ki	420
Jamaican Style Beef Patties	590
Kalua Pork Spring Rolls	500
Beef Birria	1090
BBQ Teriyaki Chicken	710
Italian Style Meatballs	450
Premium Salmon Burgers	330
Mandarin Orange Chicken	330
Egg Frittata	620
Mexican Style Roasted Corn	115
Mixed Mushroom & Spinach Quiche	660
BBQ Teriyaki Chicken	710
Eggwich Breadless Breakfast Sandwhich	610
Southwest Style Chicken Quesadillas	440
Kimchi & Tofu Soup	980
Vegetable Pad Thai	950
Spicy Thai Shrimp Fried Rice	400
Carne Asada Burritos	880
Vegan Pasta Bolognese Bowl	690
Cheese Filled Fiocchetti with Pink Sauce	370
Quiche Lorraine	470
Beef Pho	860
Cauliflower Gnocchi	460
Gluten Free Mac & Cheese	600
Steamed Pork & Ginger Soup Dumplings	560
Sriracha Shrimp Bowl	690
Chicken-less Mandarin Orange Morsels	720
Pizza Parlano	620
Outside-In Stuffed Gnocchi	680
Cuban Style Citrus Garlic Bowl	540
Honey Walnut Shrimp	670
Chipotle Vegetable Quesadillas	510

Carbohydrate, by difference

\	
Food Item	
Vegetable Fried Rice	45
Korean Beefless Bulgogi	15
Cheese & Green Chile Tamales	28
Stir Fried Garlicky Cabbage	9
Vegetarian Meatless Cheeseburger Pizza	37
Roasted Garlic & Pesto Pizza with Deep Fried Crust	43
Chickenless Crispy Tenders	14
Bulgogi Beef Fried Rice with Kimchi	60
Bulgur Pilaf with Butternut Squash & Feta Cheese	20
Chicken Burrito Bowl	51

Italian Tomato & Red Onion Focaccia	48
Cuban Style Citrus Garlic Bowl	44
Hashbrowns	15
Pão D'Água Portuguese Rolls	33
Layered Beef Tostada	38
Mini Chicken Tacos	24
Mini Beef Tacos	23
Hatch Chile Mac & Cheese	31
Tteok Bok Ki	61
Jamaican Style Beef Patties	45
Kalua Pork Spring Rolls	33
Beef Birria	3
BBQ Teriyaki Chicken	11
Italian Style Meatballs	5
Premium Salmon Burgers	3
Mandarin Orange Chicken	24
Egg Frittata	10
Mexican Style Roasted Corn	21
Mixed Mushroom & Spinach Quiche	35
BBQ Teriyaki Chicken	11
Eggwich Breadless Breakfast Sandwhich	3
Southwest Style Chicken Quesadillas	36
Kimchi & Tofu Soup	43
Vegetable Pad Thai	55
Spicy Thai Shrimp Fried Rice	37
Carne Asada Burritos	55
Vegan Pasta Bolognese Bowl	55
Cheese Filled Fiocchetti with Pink Sauce	26
Quiche Lorraine	20
Beef Pho	34
Cauliflower Gnocchi	22
Gluten Free Mac & Cheese	41
Steamed Pork & Ginger Soup Dumplings	30
Sriracha Shrimp Bowl	47
Chicken-less Mandarin Orange Morsels	29
Pizza Parlano	33
Outside-In Stuffed Gnocchi	29
Cuban Style Citrus Garlic Bowl	44
Honey Walnut Shrimp	22
Chipotle Vegetable Quesadillas	47

Fiber, total dietary \

Food Item	
Vegetable Fried Rice	3
Korean Beefless Bulgogi	5
Cheese & Green Chile Tamales	2
Stir Fried Garlicky Cabbage	4

Vegetarian Meatless Cheeseburger Pizza	3
Roasted Garlic & Pesto Pizza with Deep Fried Crust	3
Chickenless Crispy Tenders	4
Bulgogi Beef Fried Rice with Kimchi	3
Bulgur Pilaf with Butternut Squash & Feta Cheese	2
Chicken Burrito Bowl	9
Italian Tomato & Red Onion Focaccia	3
Cuban Style Citrus Garlic Bowl	1
Hashbrowns	1
Pão D'Água Portuguese Rolls	2
Layered Beef Tostada	8
Mini Chicken Tacos	4
Mini Beef Tacos	5
Hatch Chile Mac & Cheese	1
Tteok Bok Ki	3
Jamaican Style Beef Patties	3
Kalua Pork Spring Rolls	2
Beef Birria	0
BBQ Teriyaki Chicken	1
Italian Style Meatballs	1
Premium Salmon Burgers	0
Mandarin Orange Chicken	1
Egg Frittata	1
Mexican Style Roasted Corn	5
Mixed Mushroom & Spinach Quiche	2
BBQ Teriyaki Chicken	1
Eggwich Breadless Breakfast Sandwhich	0
Southwest Style Chicken Quesadillas	3
Kimchi & Tofu Soup	4
Vegetable Pad Thai	5
Spicy Thai Shrimp Fried Rice	1
Carne Asada Burritos	3
Vegan Pasta Bolognese Bowl	13
Cheese Filled Fiocchetti with Pink Sauce	1
Quiche Lorraine	1
Beef Pho	1
Cauliflower Gnocchi	6
Gluten Free Mac & Cheese	1
Steamed Pork & Ginger Soup Dumplings	1
Sriracha Shrimp Bowl	1
Chicken-less Mandarin Orange Morsels	7
Pizza Parlano	1
Outside-In Stuffed Gnocchi	3
Cuban Style Citrus Garlic Bowl	1
Honey Walnut Shrimp	2
Chipotle Vegetable Quesadillas	4

Food Item	Total Sugars (g) \
Vegetable Fried Rice	3
Korean Beefless Bulgogi	6
Cheese & Green Chile Tamales	2
Stir Fried Garlicky Cabbage	5
Vegetarian Meatless Cheeseburger Pizza	4
Roasted Garlic & Pesto Pizza with Deep Fried Crust	1
Chickenless Crispy Tenders	1
Bulgogi Beef Fried Rice with Kimchi	7
Bulgur Pilaf with Butternut Squash & Feta Cheese	3
Chicken Burrito Bowl	2
Italian Tomato & Red Onion Focaccia	13
Cuban Style Citrus Garlic Bowl	13
Hashbrowns	0
Pão D'Água Portuguese Rolls	2
Layered Beef Tostada	3
Mini Chicken Tacos	1
Mini Beef Tacos	1
Hatch Chile Mac & Cheese	3
Tteok Bok Ki	10
Jamaican Style Beef Patties	4
Kalua Pork Spring Rolls	3
Beef Birria	1
BBQ Teriyaki Chicken	10
Italian Style Meatballs	2
Premium Salmon Burgers	1
Mandarin Orange Chicken	6
Egg Frittata	3
Mexican Style Roasted Corn	8
Mixed Mushroom & Spinach Quiche	1
BBQ Teriyaki Chicken	10
Eggwich Breadless Breakfast Sandwhich	1
Southwest Style Chicken Quesadillas	2
Kimchi & Tofu Soup	14
Vegetable Pad Thai	27
Spicy Thai Shrimp Fried Rice	2
Carne Asada Burritos	2
Vegan Pasta Bolognese Bowl	10
Cheese Filled Fiocchetti with Pink Sauce	2
Quiche Lorraine	2
Beef Pho	1
Cauliflower Gnocchi	1
Gluten Free Mac & Cheese	3
Steamed Pork & Ginger Soup Dumplings	3
Sriracha Shrimp Bowl	3
Chicken-less Mandarin Orange Morsels	15

Pizza Parlano	5
Outside-In Stuffed Gnocchi	6
Cuban Style Citrus Garlic Bowl	13
Honey Walnut Shrimp	26
Chipotle Vegetable Quesadillas	3

Food Item	Added Sugars (g)	Protein \
Vegetable Fried Rice	1	6
Korean Beefless Bulgogi	6	16
Cheese & Green Chile Tamales	0	8
Stir Fried Garlicky Cabbage	1	3
Vegetarian Meatless Cheeseburger Pizza	0	14
Roasted Garlic & Pesto Pizza with Deep Fried Crust	0	17
Chickenless Crispy Tenders	1	13
Bulgogi Beef Fried Rice with Kimchi	5	11
Bulgur Pilaf with Butternut Squash & Feta Cheese	0	6
Chicken Burrito Bowl	0	22
Italian Tomato & Red Onion Focaccia	0	8
Cuban Style Citrus Garlic Bowl	3	16
Hashbrowns	0	1
Pão D'Água Portuguese Rolls	0	5
Layered Beef Tostada	1	28
Mini Chicken Tacos	0	11
Mini Beef Tacos	0	11
Hatch Chile Mac & Cheese	0	11
Tteok Bok Ki	10	5
Jamaican Style Beef Patties	1	15
Kalua Pork Spring Rolls	0	8
Beef Birria	0	32
BBQ Teriyaki Chicken	10	31
Italian Style Meatballs	11	0
Premium Salmon Burgers	1	15
Mandarin Orange Chicken	0	21
Egg Frittata	0	25
Mexican Style Roasted Corn	0	5
Mixed Mushroom & Spinach Quiche	0	12
BBQ Teriyaki Chicken	10	31
Eggwich Breadless Breakfast Sandwhich	0	16
Southwest Style Chicken Quesadillas	0	23
Kimchi & Tofu Soup	4	11
Vegetable Pad Thai	20	10
Spicy Thai Shrimp Fried Rice	0	7
Carne Asada Burritos	0	22
Vegan Pasta Bolognese Bowl	0	30
Cheese Filled Fiocchetti with Pink Sauce	0	8
Quiche Lorraine	0	15

Beef Pho	0	13
Cauliflower Gnocchi	0	2
Gluten Free Mac & Cheese	0	11
Steamed Pork & Ginger Soup Dumplings	2	14
Sriracha Shrimp Bowl	2	15
Chicken-less Mandarin Orange Morsels	15	20
Pizza Parlano	13	0
Outside-In Stuffed Gnocchi	0	6
Cuban Style Citrus Garlic Bowl	3	16
Honey Walnut Shrimp	23	24
Chipotle Vegetable Quesadillas	2	15

Food Item	Vitamin D (mcg)	\
Vegetable Fried Rice	0.0	
Korean Beefless Bulgogi	0.0	
Cheese & Green Chile Tamales	0.1	
Stir Fried Garlicky Cabbage	0.0	
Vegetarian Meatless Cheeseburger Pizza	0.0	
Roasted Garlic & Pesto Pizza with Deep Fried Crust	0.3	
Chickenless Crispy Tenders	0.0	
Bulgogi Beef Fried Rice with Kimchi	0.0	
Bulgur Pilaf with Butternut Squash & Feta Cheese	0.0	
Chicken Burrito Bowl	0.0	
Italian Tomato & Red Onion Focaccia	0.0	
Cuban Style Citrus Garlic Bowl	0.2	
Hashbrowns	0.0	
Pão D'Água Portuguese Rolls	0.0	
Layered Beef Tostada	0.0	
Mini Chicken Tacos	0.0	
Mini Beef Tacos	0.0	
Hatch Chile Mac & Cheese	25.0	
Tteok Bok Ki	0.0	
Jamaican Style Beef Patties	0.0	
Kalua Pork Spring Rolls	0.0	
Beef Birria	0.0	
BBQ Teriyaki Chicken	0.0	
Italian Style Meatballs	0.0	
Premium Salmon Burgers	20.9	
Mandarin Orange Chicken	0.0	
Egg Frittata	0.3	
Mexican Style Roasted Corn	0.0	
Mixed Mushroom & Spinach Quiche	1.8	
BBQ Teriyaki Chicken	0.0	
Eggwich Breadless Breakfast Sandwhich	1.3	
Southwest Style Chicken Quesadillas	0.2	
Kimchi & Tofu Soup	0.0	

Vegetable Pad Thai	0.0
Spicy Thai Shrimp Fried Rice	0.8
Carne Asada Burritos	0.0
Vegan Pasta Bolognese Bowl	0.0
Cheese Filled Fiocchetti with Pink Sauce	0.0
Quiche Lorraine	1.0
Beef Pho	0.0
Cauliflower Gnocchi	0.0
Gluten Free Mac & Cheese	0.7
Steamed Pork & Ginger Soup Dumplings	0.2
Sriracha Shrimp Bowl	3.5
Chicken-less Mandarin Orange Morsels	0.0
Pizza Parlano	0.0
Outside-In Stuffed Gnocchi	0.0
Cuban Style Citrus Garlic Bowl	0.2
Honey Walnut Shrimp	0.0
Chipotle Vegetable Quesadillas	0.1

Food Item	Calcium, Ca	Iron, Fe \
Vegetable Fried Rice	0	0.9
Korean Beefless Bulgogi	60	5.3
Cheese & Green Chile Tamales	200	1.2
Stir Fried Garlicky Cabbage	50	0.5
Vegetarian Meatless Cheeseburger Pizza	190	2.4
Roasted Garlic & Pesto Pizza with Deep Fried Crust	260	1.2
Chickenless Crispy Tenders	30	1.4
Bulgogi Beef Fried Rice with Kimchi	50	1.5
Bulgur Pilaf with Butternut Squash & Feta Cheese	40	1.0
Chicken Burrito Bowl	130	2.6
Italian Tomato & Red Onion Focaccia	20	0.8
Cuban Style Citrus Garlic Bowl	30	2.3
Hashbrowns	10	0.4
Pão D'Água Portuguese Rolls	60	0.8
Layered Beef Tostada	260	3.9
Mini Chicken Tacos	30	0.6
Mini Beef Tacos	40	1.1
Hatch Chile Mac & Cheese	260	1.4
Tteok Bok Ki	30	1.1
Jamaican Style Beef Patties	50	3.1
Kalua Pork Spring Rolls	30	0.8
Beef Birria	20	4.5
BBQ Teriyaki Chicken	10	1.2
Italian Style Meatballs	0	0.0
Premium Salmon Burgers	0	0.3
Mandarin Orange Chicken	0	0.0
Egg Frittata	390	0.7

Mexican Style Roasted Corn	30	0.4
Mixed Mushroom & Spinach Quiche	300	1.2
BBQ Teriyaki Chicken	10	1.2
Eggwich Breadless Breakfast Sandwhich	120	1.9
Southwest Style Chicken Quesadillas	450	1.4
Kimchi & Tofu Soup	90	2.3
Vegetable Pad Thai	50	2.0
Spicy Thai Shrimp Fried Rice	20	0.4
Carne Asada Burritos	100	2.9
Vegan Pasta Bolognese Bowl	90	5.4
Cheese Filled Fiocchetti with Pink Sauce	100	0.7
Quiche Lorraine	180	2.0
Beef Pho	40	1.6
Cauliflower Gnocchi	40	0.9
Gluten Free Mac & Cheese	140	0.7
Steamed Pork & Ginger Soup Dumplings	20	1.9
Sriracha Shrimp Bowl	220	1.6
Chicken-less Mandarin Orange Morsels	50	2.0
Pizza Parlano	0	0.0
Outside-In Stuffed Gnocchi	60	0.5
Cuban Style Citrus Garlic Bowl	30	2.3
Honey Walnut Shrimp	63	0.0
Chipotle Vegetable Quesadillas	290	2.0

Potassium, K

Food Item	
Vegetable Fried Rice	190
Korean Beefless Bulgogi	190
Cheese & Green Chile Tamales	200
Stir Fried Garlicky Cabbage	350
Vegetarian Meatless Cheeseburger Pizza	310
Roasted Garlic & Pesto Pizza with Deep Fried Crust	170
Chickenless Crispy Tenders	270
Bulgogi Beef Fried Rice with Kimchi	300
Bulgur Pilaf with Butternut Squash & Feta Cheese	250
Chicken Burrito Bowl	690
Italian Tomato & Red Onion Focaccia	250
Cuban Style Citrus Garlic Bowl	300
Hashbrowns	210
Pão D'Água Portuguese Rolls	70
Layered Beef Tostada	520
Mini Chicken Tacos	200
Mini Beef Tacos	180
Hatch Chile Mac & Cheese	190
Tteok Bok Ki	130
Jamaican Style Beef Patties	220
Kalua Pork Spring Rolls	220

Beef Birria	650
BBQ Teriyaki Chicken	350
Italian Style Meatballs	0
Premium Salmon Burgers	320
Mandarin Orange Chicken	0
Egg Frittata	260
Mexican Style Roasted Corn	200
Mixed Mushroom & Spinach Quiche	540
BBQ Teriyaki Chicken	350
Eggwich Breadless Breakfast Sandwhich	190
Southwest Style Chicken Quesadillas	270
Kimchi & Tofu Soup	330
Vegetable Pad Thai	410
Spicy Thai Shrimp Fried Rice	130
Carne Asada Burritos	360
Vegan Pasta Bolognese Bowl	1540
Cheese Filled Focchetti with Pink Sauce	160
Quiche Lorraine	210
Beef Pho	240
Cauliflower Gnocchi	210
Gluten Free Mac & Cheese	80
Steamed Pork & Ginger Soup Dumplings	190
Sriracha Shrimp Bowl	340
Chicken-less Mandarin Orange Morsels	400
Pizza Parlano	0
Outside-In Stuffed Gnocchi	390
Cuban Style Citrus Garlic Bowl	300
Honey Walnut Shrimp	141
Chipotle Vegetable Quesadillas	250

```
[10]: p = food_data["Price of Item (USD)"]/food_data['Number of Servings']
      p
```

[10]: Food Item	
Vegetable Fried Rice	0.996667
Korean Beefless Bulgogi	1.496667
Cheese & Green Chile Tamales	1.895000
Stir Fried Garlicky Cabbage	1.745000
Vegetarian Meatless Cheeseburger Pizza	1.996667
Roasted Garlic & Pesto Pizza with Deep Fried Crust	1.996667
Chickenless Crispy Tenders	1.263333
Bulgogi Beef Fried Rice with Kimchi	5.490000
Bulgur Pilaf with Butternut Squash & Feta Cheese	0.997143
Chicken Burrito Bowl	3.490000
Italian Tomato & Red Onion Focaccia	1.330000
Cuban Style Citrus Garlic Bowl	3.990000
Hashbrowns	0.249000

Pão D'Água Portuguese Rolls	0.572500
Layered Beef Tostada	3.990000
Mini Chicken Tacos	0.998333
Mini Beef Tacos	0.998333
Hatch Chile Mac & Cheese	1.495000
Tteok Bok Ki	3.990000
Jamaican Style Beef Patties	4.490000
Kalua Pork Spring Rolls	2.395000
Beef Birria	3.995000
BBQ Teriyaki Chicken	1.497500
Italian Style Meatballs	0.831667
Premium Salmon Burgers	1.872500
Mandarin Orange Chicken	0.998000
Egg Frittata	3.490000
Mexican Style Roasted Corn	1.082857
Mixed Mushroom & Spinach Quiche	2.690000
BBQ Teriyaki Chicken	1.497500
Eggwich Breadless Breakfast Sandwhich	2.495000
Southwest Style Chicken Quesadillas	2.145000
Kimchi & Tofu Soup	3.490000
Vegetable Pad Thai	3.490000
Spicy Thai Shrimp Fried Rice	1.996667
Carne Asada Burritos	2.495000
Vegan Pasta Bolognese Bowl	3.490000
Cheese Filled Fiocchetti with Pink Sauce	1.330000
Quiche Lorraine	1.830000
Beef Pho	3.490000
Cauliflower Gnocchi	1.196000
Gluten Free Mac & Cheese	1.845000
Steamed Pork & Ginger Soup Dumplings	3.490000
Sriracha Shrimp Bowl	3.490000
Chicken-less Mandarin Orange Morsels	1.895000
Pizza Parlano	1.247500
Outside-In Stuffed Gnocchi	1.054286
Cuban Style Citrus Garlic Bowl	3.990000
Honey Walnut Shrimp	3.495000
Chipotle Vegetable Quesadillas	1.845000
dtype: float64	

1.1 [A] Nutritional content of different foods

```
[11]: # Due to mismatch of nutrients between requirement.txt and the nutrients' data,
      ↪available,
      # we dropped some of the nutrients' requirements
```

```
diet_minimum = diet_minimum.drop(['Folate, DFE', 'Magnesium, Mg', 'Niacin',
↳ 'Phosphorus, P', 'Riboflavin', 'Thiamin', 'Vitamin A, RAE', 'Vitamin B-12',
↳ 'Vitamin B-6', 'Vitamin C, total ascorbic acid', 'Vitamin E',
↳ (alpha-tocopherol)', 'Vitamin K (phylloquinone)', 'Zinc, Zn'])
```

```
[12]: D = food_data.drop(["Number of Servings","Price of Item (USD)"], axis = 1)
D = D.T
D
```

```
[12]: Food Item      Vegetable Fried Rice  Korean Beefless Bulgogi \
Energy              230.0              230.0
Total Fat (g)        2.5              11.0
Saturated Fat (g)    0.0              2.0
Trans Fat (g)        0.0              0.0
Cholestrol (mg)      0.0              0.0
Sodium, Na          510.0             580.0
Carbohydrate, by difference  45.0             15.0
Fiber, total dietary  3.0              5.0
Total Sugars (g)      3.0              6.0
Added Sugars (g)     1.0              6.0
Protein              6.0              16.0
Vitamin D (mcg)       0.0              0.0
Calcium, Ca          0.0             60.0
Iron, Fe             0.9              5.3
Potassium, K         190.0             190.0
```

```
Food Item      Cheese & Green Chile Tamales \
Energy              290.0
Total Fat (g)       16.0
Saturated Fat (g)    6.0
Trans Fat (g)       0.0
Cholestrol (mg)     20.0
Sodium, Na         610.0
Carbohydrate, by difference  28.0
Fiber, total dietary  2.0
Total Sugars (g)     2.0
Added Sugars (g)     0.0
Protein             8.0
Vitamin D (mcg)      0.1
Calcium, Ca        200.0
Iron, Fe            1.2
Potassium, K       200.0
```

```
Food Item      Stir Fried Garlicky Cabbage \
Energy          130.0
Total Fat (g)    9.0
Saturated Fat (g) 2.0
```

Trans Fat (g)	0.0
Cholestrol (mg)	0.0
Sodium, Na	620.0
Carbohydrate, by difference	9.0
Fiber, total dietary	4.0
Total Sugars (g)	5.0
Added Sugars (g)	1.0
Protein	3.0
Vitamin D (mcg)	0.0
Calcium, Ca	50.0
Iron, Fe	0.5
Potassium, K	350.0

Food Item	Vegetarian Meatless Cheeseburger Pizza \
Energy	340.0
Total Fat (g)	15.0
Saturated Fat (g)	5.0
Trans Fat (g)	0.0
Cholestrol (mg)	20.0
Sodium, Na	790.0
Carbohydrate, by difference	37.0
Fiber, total dietary	3.0
Total Sugars (g)	4.0
Added Sugars (g)	0.0
Protein	14.0
Vitamin D (mcg)	0.0
Calcium, Ca	190.0
Iron, Fe	2.4
Potassium, K	310.0

Food Item	Roasted Garlic & Pesto Pizza with Deep Fried Crust \
Energy	430.0
Total Fat (g)	20.0
Saturated Fat (g)	9.0
Trans Fat (g)	0.0
Cholestrol (mg)	25.0
Sodium, Na	900.0
Carbohydrate, by difference	43.0
Fiber, total dietary	3.0
Total Sugars (g)	1.0
Added Sugars (g)	0.0
Protein	17.0
Vitamin D (mcg)	0.3
Calcium, Ca	260.0
Iron, Fe	1.2
Potassium, K	170.0

Food Item	Chickenless Crispy Tenders \
Energy	170.0
Total Fat (g)	7.0
Saturated Fat (g)	0.5
Trans Fat (g)	0.0
Cholestrol (mg)	0.0
Sodium, Na	380.0
Carbohydrate, by difference	14.0
Fiber, total dietary	4.0
Total Sugars (g)	1.0
Added Sugars (g)	1.0
Protein	13.0
Vitamin D (mcg)	0.0
Calcium, Ca	30.0
Iron, Fe	1.4
Potassium, K	270.0

Food Item	Bulgogi Beef Fried Rice with Kimchi \
Energy	400.0
Total Fat (g)	10.0
Saturated Fat (g)	1.5
Trans Fat (g)	0.0
Cholestrol (mg)	20.0
Sodium, Na	1150.0
Carbohydrate, by difference	60.0
Fiber, total dietary	3.0
Total Sugars (g)	7.0
Added Sugars (g)	5.0
Protein	11.0
Vitamin D (mcg)	0.0
Calcium, Ca	50.0
Iron, Fe	1.5
Potassium, K	300.0

Food Item	Bulgur Pilaf with Butternut Squash & Feta Cheese \
Energy	200.0
Total Fat (g)	10.0
Saturated Fat (g)	3.0
Trans Fat (g)	0.0
Cholestrol (mg)	10.0
Sodium, Na	380.0
Carbohydrate, by difference	20.0
Fiber, total dietary	2.0
Total Sugars (g)	3.0
Added Sugars (g)	0.0
Protein	6.0

Vitamin D (mcg)	0.0
Calcium, Ca	40.0
Iron, Fe	1.0
Potassium, K	250.0

Food Item	Chicken Burrito Bowl ...	Cauliflower Gnocchi \
Energy	370.0 ...	140.0
Total Fat (g)	10.0 ...	3.0
Saturated Fat (g)	4.5 ...	0.5
Trans Fat (g)	0.0 ...	0.0
Cholestrol (mg)	55.0 ...	0.0
Sodium, Na	630.0 ...	460.0
Carbohydrate, by difference	51.0 ...	22.0
Fiber, total dietary	9.0 ...	6.0
Total Sugars (g)	2.0 ...	1.0
Added Sugars (g)	0.0 ...	0.0
Protein	22.0 ...	2.0
Vitamin D (mcg)	0.0 ...	0.0
Calcium, Ca	130.0 ...	40.0
Iron, Fe	2.6 ...	0.9
Potassium, K	690.0 ...	210.0

Food Item	Gluten Free Mac & Cheese \
Energy	300.0
Total Fat (g)	10.0
Saturated Fat (g)	5.0
Trans Fat (g)	0.0
Cholestrol (mg)	30.0
Sodium, Na	600.0
Carbohydrate, by difference	41.0
Fiber, total dietary	1.0
Total Sugars (g)	3.0
Added Sugars (g)	0.0
Protein	11.0
Vitamin D (mcg)	0.7
Calcium, Ca	140.0
Iron, Fe	0.7
Potassium, K	80.0

Food Item	Steamed Pork & Ginger Soup Dumplings \
Energy	270.0
Total Fat (g)	10.0
Saturated Fat (g)	3.0
Trans Fat (g)	0.0
Cholestrol (mg)	40.0
Sodium, Na	560.0
Carbohydrate, by difference	30.0

Fiber, total dietary	1.0
Total Sugars (g)	3.0
Added Sugars (g)	2.0
Protein	14.0
Vitamin D (mcg)	0.2
Calcium, Ca	20.0
Iron, Fe	1.9
Potassium, K	190.0

Food Item	Sriracha Shrimp Bowl \
Energy	320.0
Total Fat (g)	8.0
Saturated Fat (g)	1.5
Trans Fat (g)	0.0
Cholestrol (mg)	35.0
Sodium, Na	690.0
Carbohydrate, by difference	47.0
Fiber, total dietary	1.0
Total Sugars (g)	3.0
Added Sugars (g)	2.0
Protein	15.0
Vitamin D (mcg)	3.5
Calcium, Ca	220.0
Iron, Fe	1.6
Potassium, K	340.0

Food Item	Chicken-less Mandarin Orange Morsels \
Energy	270.0
Total Fat (g)	8.0
Saturated Fat (g)	0.5
Trans Fat (g)	0.0
Cholestrol (mg)	0.0
Sodium, Na	720.0
Carbohydrate, by difference	29.0
Fiber, total dietary	7.0
Total Sugars (g)	15.0
Added Sugars (g)	15.0
Protein	20.0
Vitamin D (mcg)	0.0
Calcium, Ca	50.0
Iron, Fe	2.0
Potassium, K	400.0

Food Item	Pizza Parlano	Outside-In Stuffed Gnocchi \
Energy	330.0	180.0
Total Fat (g)	16.0	3.5
Saturated Fat (g)	6.0	2.0

Trans Fat (g)	0.0	0.0
Cholestrol (mg)	30.0	30.0
Sodium, Na	620.0	680.0
Carbohydrate, by difference	33.0	29.0
Fiber, total dietary	1.0	3.0
Total Sugars (g)	5.0	6.0
Added Sugars (g)	13.0	0.0
Protein	0.0	6.0
Vitamin D (mcg)	0.0	0.0
Calcium, Ca	0.0	60.0
Iron, Fe	0.0	0.5
Potassium, K	0.0	390.0

Food Item	Cuban Style Citrus Garlic Bowl \
Energy	400.0
Total Fat (g)	18.0
Saturated Fat (g)	2.0
Trans Fat (g)	0.0
Cholestrol (mg)	45.0
Sodium, Na	540.0
Carbohydrate, by difference	44.0
Fiber, total dietary	1.0
Total Sugars (g)	13.0
Added Sugars (g)	3.0
Protein	16.0
Vitamin D (mcg)	0.2
Calcium, Ca	30.0
Iron, Fe	2.3
Potassium, K	300.0

Food Item	Honey Walnut Shrimp \
Energy	500.0
Total Fat (g)	28.0
Saturated Fat (g)	8.0
Trans Fat (g)	0.0
Cholestrol (mg)	125.0
Sodium, Na	670.0
Carbohydrate, by difference	22.0
Fiber, total dietary	2.0
Total Sugars (g)	26.0
Added Sugars (g)	23.0
Protein	24.0
Vitamin D (mcg)	0.0
Calcium, Ca	63.0
Iron, Fe	0.0
Potassium, K	141.0

Food Item	Chipotle Vegetable Quesadillas
Energy	360.0
Total Fat (g)	13.0
Saturated Fat (g)	5.0
Trans Fat (g)	0.0
Cholestrol (mg)	30.0
Sodium, Na	510.0
Carbohydrate, by difference	47.0
Fiber, total dietary	4.0
Total Sugars (g)	3.0
Added Sugars (g)	2.0
Protein	15.0
Vitamin D (mcg)	0.1
Calcium, Ca	290.0
Iron, Fe	2.0
Potassium, K	250.0

[15 rows x 50 columns]

1.2 [A] Solution

```
[13]: Amin = D.loc[diet_minimum.index]
      Amax = D.loc[diet_maximum.index]
      A = pd.concat([Amin, -Amax])
      A
```

[13]: Food Item	Vegetable Fried Rice	Korean Beefless Bulgogi \
Nutrition		
Energy	230.0	230.0
Protein	6.0	16.0
Fiber, total dietary	3.0	5.0
Calcium, Ca	0.0	60.0
Carbohydrate, by difference	45.0	15.0
Iron, Fe	0.9	5.3
Potassium, K	190.0	190.0
Sodium, Na	-510.0	-580.0
Energy	-230.0	-230.0

Food Item	Cheese & Green Chile Tamales \
Nutrition	
Energy	290.0
Protein	8.0
Fiber, total dietary	2.0
Calcium, Ca	200.0
Carbohydrate, by difference	28.0
Iron, Fe	1.2
Potassium, K	200.0

Sodium, Na	-610.0
Energy	-290.0

Food Item	Stir Fried Garlicky Cabbage \
Nutrition	
Energy	130.0
Protein	3.0
Fiber, total dietary	4.0
Calcium, Ca	50.0
Carbohydrate, by difference	9.0
Iron, Fe	0.5
Potassium, K	350.0
Sodium, Na	-620.0
Energy	-130.0

Food Item	Vegetarian Meatless Cheeseburger Pizza \
Nutrition	
Energy	340.0
Protein	14.0
Fiber, total dietary	3.0
Calcium, Ca	190.0
Carbohydrate, by difference	37.0
Iron, Fe	2.4
Potassium, K	310.0
Sodium, Na	-790.0
Energy	-340.0

Food Item	Roasted Garlic & Pesto Pizza with Deep Fried Crust \
Nutrition	
Energy	430.0
Protein	17.0
Fiber, total dietary	3.0
Calcium, Ca	260.0
Carbohydrate, by difference	43.0
Iron, Fe	1.2
Potassium, K	170.0
Sodium, Na	-900.0
Energy	-430.0

Food Item	Chickenless Crispy Tenders \
Nutrition	
Energy	170.0
Protein	13.0
Fiber, total dietary	4.0
Calcium, Ca	30.0
Carbohydrate, by difference	14.0

Iron, Fe	1.4
Potassium, K	270.0
Sodium, Na	-380.0
Energy	-170.0

Food Item	Bulgogi Beef Fried Rice with Kimchi	\
Nutrition		
Energy	400.0	
Protein	11.0	
Fiber, total dietary	3.0	
Calcium, Ca	50.0	
Carbohydrate, by difference	60.0	
Iron, Fe	1.5	
Potassium, K	300.0	
Sodium, Na	-1150.0	
Energy	-400.0	

Food Item	Bulgur Pilaf with Butternut Squash & Feta Cheese	\
Nutrition		
Energy		200.0
Protein		6.0
Fiber, total dietary		2.0
Calcium, Ca		40.0
Carbohydrate, by difference		20.0
Iron, Fe		1.0
Potassium, K		250.0
Sodium, Na		-380.0
Energy		-200.0

Food Item	Chicken Burrito Bowl	...	Cauliflower Gnocchi	\
Nutrition		...		
Energy	370.0	...	140.0	
Protein	22.0	...	2.0	
Fiber, total dietary	9.0	...	6.0	
Calcium, Ca	130.0	...	40.0	
Carbohydrate, by difference	51.0	...	22.0	
Iron, Fe	2.6	...	0.9	
Potassium, K	690.0	...	210.0	
Sodium, Na	-630.0	...	-460.0	
Energy	-370.0	...	-140.0	

Food Item	Gluten Free Mac & Cheese	\
Nutrition		
Energy	300.0	
Protein	11.0	
Fiber, total dietary	1.0	
Calcium, Ca	140.0	

Carbohydrate, by difference	41.0
Iron, Fe	0.7
Potassium, K	80.0
Sodium, Na	-600.0
Energy	-300.0

Food Item	Steamed Pork & Ginger Soup Dumplings	\
Nutrition		
Energy		270.0
Protein		14.0
Fiber, total dietary		1.0
Calcium, Ca		20.0
Carbohydrate, by difference		30.0
Iron, Fe		1.9
Potassium, K		190.0
Sodium, Na		-560.0
Energy		-270.0

Food Item	Sriracha Shrimp Bowl	\
Nutrition		
Energy	320.0	
Protein	15.0	
Fiber, total dietary	1.0	
Calcium, Ca	220.0	
Carbohydrate, by difference	47.0	
Iron, Fe	1.6	
Potassium, K	340.0	
Sodium, Na	-690.0	
Energy	-320.0	

Food Item	Chicken-less Mandarin Orange Morsels	\
Nutrition		
Energy		270.0
Protein		20.0
Fiber, total dietary		7.0
Calcium, Ca		50.0
Carbohydrate, by difference		29.0
Iron, Fe		2.0
Potassium, K		400.0
Sodium, Na		-720.0
Energy		-270.0

Food Item	Pizza Parlano	Outside-In Stuffed Gnocchi	\
Nutrition			
Energy	330.0		180.0
Protein	0.0		6.0
Fiber, total dietary	1.0		3.0

Calcium, Ca	0.0	60.0
Carbohydrate, by difference	33.0	29.0
Iron, Fe	0.0	0.5
Potassium, K	0.0	390.0
Sodium, Na	-620.0	-680.0
Energy	-330.0	-180.0

Food Item	Cuban Style Citrus Garlic Bowl \	
Nutrition		
Energy		400.0
Protein		16.0
Fiber, total dietary		1.0
Calcium, Ca		30.0
Carbohydrate, by difference		44.0
Iron, Fe		2.3
Potassium, K		300.0
Sodium, Na		-540.0
Energy		-400.0

Food Item	Honey Walnut Shrimp \	
Nutrition		
Energy	500.0	
Protein	24.0	
Fiber, total dietary	2.0	
Calcium, Ca	63.0	
Carbohydrate, by difference	22.0	
Iron, Fe	0.0	
Potassium, K	141.0	
Sodium, Na	-670.0	
Energy	-500.0	

Food Item	Chipotle Vegetable Quesadillas	
Nutrition		
Energy		360.0
Protein		15.0
Fiber, total dietary		4.0
Calcium, Ca		290.0
Carbohydrate, by difference		47.0
Iron, Fe		2.0
Potassium, K		250.0
Sodium, Na		-510.0
Energy		-360.0

[9 rows x 50 columns]

```
[14]: b = pd.concat([diet_minimum,-diet_maximum])
      b
```

```
[14]:
```

	C 1-3	F 4-8	M 4-8	F 9-13	M 9-13	F 14-18	\
Nutrition							
Energy	1000.0	1200.0	1400.0	1600.0	1800.0	1800.0	
Protein	13.0	19.0	19.0	34.0	34.0	46.0	
Fiber, total dietary	14.0	16.8	19.6	22.4	25.2	25.2	
Calcium, Ca	700.0	1000.0	1000.0	1300.0	1300.0	1300.0	
Carbohydrate, by difference	130.0	130.0	130.0	130.0	130.0	130.0	
Iron, Fe	7.0	10.0	10.0	8.0	8.0	15.0	
Potassium, K	3000.0	3800.0	3800.0	4500.0	4500.0	4700.0	
Sodium, Na	-1500.0	-1900.0	-1900.0	-2200.0	-2200.0	-2300.0	
Energy	-2500.0	-2500.0	-2500.0	-2800.0	-3000.0	-3100.0	

	M 14-18	F 19-30	M 19-30	F 31-50	M 31-50	\
Nutrition						
Energy	2200.0	2000.0	2400.0	1800.0	2200.0	
Protein	52.0	46.0	56.0	46.0	56.0	
Fiber, total dietary	30.8	28.0	33.6	25.2	30.8	
Calcium, Ca	1300.0	1000.0	1000.0	1000.0	1000.0	
Carbohydrate, by difference	130.0	130.0	130.0	130.0	130.0	
Iron, Fe	11.0	18.0	8.0	18.0	8.0	
Potassium, K	4700.0	4700.0	4700.0	4700.0	4700.0	
Sodium, Na	-2300.0	-2300.0	-2300.0	-2300.0	-2300.0	
Energy	-3100.0	-3100.0	-3100.0	-3100.0	-3100.0	

	F 51+	M 51+
Nutrition		
Energy	1600.0	2000.0
Protein	46.0	56.0
Fiber, total dietary	22.4	28.0
Calcium, Ca	1200.0	1000.0
Carbohydrate, by difference	130.0	130.0
Iron, Fe	8.0	8.0
Potassium, K	4700.0	4700.0
Sodium, Na	-2300.0	-2300.0
Energy	-3100.0	-3100.0

```
[15]: # A function that takes in FoodNutrients (A); price (p); DailyNutrients (b);
      ↪ and group of interests
      # groups of interest must come from b.columns
      def solve_subsistence_problem(FoodNutrients, price, DailyNutrients, group,
      ↪ tol=1e-5):
          result = lp(price, -FoodNutrients,
          ↪ -DailyNutrients[group], method='interior-point')
          return result
```

1.2.1 Solution 1: Female 19-30, only eating Trader Joe's Frozen Food

1) Without calorie and sodium restriction

```
[16]: group = "F 19-30"
      tol=1e-5
      result = solve_subsistence_problem(Amin, p, diet_minimum, group, tol)
      print(result.message)
      print(f"Cost of diet for {group} is ${result.fun:.2f} per day.")
      diet = pd.Series(result.x, index=p.index)

      print("\nYou'll be eating (in serving):")
      print(diet[diet >= tol])

      tab = pd.DataFrame({"Outcome":np.abs(Amin).dot(diet), "Recommendation":np.
        ↪abs(diet_minimum[group])})
      print("\nWith the following nutritional outcomes of interest:")
      tab
```

Optimization terminated successfully.

Cost of diet for F 19-30 is \$10.45 per day.

You'll be eating (in serving):

Food Item

Korean Beefless Bulgogi	1.546053
-------------------------	----------

Hashbrowns	18.930921
------------	-----------

Southwest Style Chicken Quesadillas	1.595395
-------------------------------------	----------

dtype: float64

With the following nutritional outcomes of interest:

```
[16]:
```

	Outcome	Recommendation
Nutrition		
Energy	3281.414506	2000.0
Protein	80.361842	46.0
Fiber, total dietary	31.447369	28.0
Calcium, Ca	1000.000001	1000.0
Carbohydrate, by difference	364.588821	130.0
Iron, Fe	18.000000	18.0
Potassium, K	4700.000063	4700.0

2) With only Energy, Protein, Fiber, Sodium Requirements

```
[17]: A_limit = A.loc[["Energy", "Protein", "Fiber, total dietary", "Sodium, Na"]]
      b_limit = b.loc[["Energy", "Protein", "Fiber, total dietary", "Sodium, Na"]]
      result = solve_subsistence_problem(A_limit, p, b_limit, group, tol)
      print(result.message)
      print(f"Cost of diet for {group} is ${result.fun:.2f} per day.")
      diet = pd.Series(result.x, index=p.index)
```

```

print("\nYou'll be eating (in serving):")
print(diet[diet >= tol])

tab = pd.DataFrame({"Outcome":np.abs(A_limit).dot(diet),"Recommendation":np.
    ↪abs(b_limit[group])})
print("\nWith the following nutritional outcomes of interest:")
tab

```

Optimization terminated successfully.
 Cost of diet for F 19-30 is \$7.94 per day.

You'll be eating (in serving):

Food Item	
Hashbrowns	4.285406
Mandarin Orange Chicken	2.225441
Mexican Style Roasted Corn	4.297824

dtype: float64

With the following nutritional outcomes of interest:

```

[17]:

```

	Outcome	Recommendation
Nutrition		
Energy	2000.000019	2000.0
Energy	2000.000019	3100.0
Protein	72.508861	46.0
Fiber, total dietary	28.000001	28.0
Sodium, Na	2299.999911	2300.0

1.2.2 Solution 2: Male 19-30, only eating Trader Joe's Frozen Food

1) Without calorie and sodium restriction

```

[18]: group = "M 19-30"
result = solve_subsistence_problem(Amin, p, diet_minimum, group, tol)
print(result.message)
print(f"Cost of diet for {group} is ${result.fun:.2f} per day.")
diet = pd.Series(result.x,index=p.index)

print("\nYou'll be eating (in serving):")
print(diet[diet >= tol])

tab = pd.DataFrame({"Outcome":np.abs(Amin).dot(diet),"Recommendation":np.
    ↪abs(diet_minimum[group])})
print("\nWith the following nutritional outcomes of interest:")
tab

```

Optimization terminated successfully.
 Cost of diet for M 19-30 is \$10.14 per day.

You'll be eating (in serving):

Food Item	
Hashbrowns	18.542764
Mini Beef Tacos	2.033821
Southwest Style Chicken Quesadillas	1.629377

dtype: float64

With the following nutritional outcomes of interest:

	Outcome	Recommendation
Nutrition		
Energy	3442.307857	2400.0
Protein	78.390461	56.0
Fiber, total dietary	33.600000	33.6
Calcium, Ca	1000.000000	1000.0
Carbohydrate, by difference	383.576911	130.0
Iron, Fe	11.935436	8.0
Potassium, K	4700.000001	4700.0

It is interesting to see that the cost of males is lower than females. So we investigated their required nutrients' intakes and found that women require higher Iron intake. This is the reason why, without calories and sodium restriction, female's minimum cost diet requires more food.

```
[19]: nutrient_intake(23, 'male', diet_minimum)
```

Nutrition	
Energy	2400.0
Protein	56.0
Fiber, total dietary	33.6
Calcium, Ca	1000.0
Carbohydrate, by difference	130.0
Iron, Fe	8.0
Potassium, K	4700.0

Name: M 19-30, dtype: float64

```
[20]: nutrient_intake(23, 'female', diet_minimum)
```

Nutrition	
Energy	2000.0
Protein	46.0
Fiber, total dietary	28.0
Calcium, Ca	1000.0
Carbohydrate, by difference	130.0
Iron, Fe	18.0
Potassium, K	4700.0

Name: F 19-30, dtype: float64

2) With only Energy, Protein, Fiber, Sodium Requirements

```
[21]: A_limit = A.loc[["Energy","Protein","Fiber, total dietary","Sodium, Na"]]
      b_limit = b.loc[["Energy","Protein","Fiber, total dietary","Sodium, Na"]]
      result = solve_subsistence_problem(A_limit, p, b_limit, group, tol)
      print(result.message)
      print(f"Cost of diet for {group} is ${result.fun:.2f} per day.")
      diet = pd.Series(result.x,index=p.index)

      print("\nYou'll be eating (in serving):")
      print(diet[diet >= tol])

      tab = pd.DataFrame({"Outcome":np.abs(A_limit).dot(diet),"Recommendation":np.
        ↪abs(b_limit[group])})
      print("\nWith the following nutritional outcomes of interest:")
      tab
```

Optimization terminated successfully.

Cost of diet for M 19-30 is \$10.20 per day.

You'll be eating (in serving):

Food Item

Hashbrowns 1.765046

Mandarin Orange Chicken 3.669493

Mexican Style Roasted Corn 5.633092

dtype: float64

With the following nutritional outcomes of interest:

```
[21]:
```

	Outcome	Recommendation
Nutrition		
Energy	2400.000000	2400.0
Energy	2400.000000	3100.0
Protein	106.989869	56.0
Fiber, total dietary	33.600000	33.6
Sodium, Na	2299.999999	2300.0

```
[22]: data = np.array([(10.45,10.14),(7.94,10.2)], dtype = 'f')
      minimum_cost = pd.DataFrame(data, columns = ["F 19-30","M 19-30"])
      minimum_cost["conditions"] = ["Without calories & Sodium Restriction","Only_
        ↪Energy, Protein, Fiber, and Sodium Requirements"]
      minimum_cost = minimum_cost.set_index("conditions")
      minimum_cost = minimum_cost.round(decimals = 2)
      print("Daily Minimum Meal Cost $ (with only Trader Joe's Frozen Food)")
      minimum_cost
```

Daily Minimum Meal Cost \$ (with only Trader Joe's Frozen Food)

```
[22]:
```

	F 19-30	M 19-30
conditions		
Without calories & Sodium Restriction	10.45	10.14
Only Energy, Protein, Fiber, and Sodium Require...	7.94	10.20

```
[23]: data = np.array([(10.45/3,10.14/3),(7.94/3,10.2/3)], dtype = 'f')
minimum_cost_2 = pd.DataFrame(data, columns = ["F 19-30","M 19-30"])
minimum_cost_2["conditions"] = ["Without calories & Sodium Restriction","Only_
↳Energy, Protein, Fiber, and Sodium Requirements"]
minimum_cost_2 = minimum_cost_2.set_index("conditions")
minimum_cost_2 = minimum_cost_2.round(decimals = 2)
print("Daily Minimum Meal Cost $ (with 1 meal from Trader Joe's Frozen Food)")
minimum_cost_2
```

Daily Minimum Meal Cost \$ (with 1 meal from Trader Joe's Frozen Food)

```
[23]:
```

	F 19-30	M 19-30
conditions		
Without calories & Sodium Restriction	3.48	3.38
Only Energy, Protein, Fiber, and Sodium Require...	2.65	3.40

1.2.3 [C] Sensitivity of Solution

Given in previous solution, hashbrowns has been the major component of our minimum cost diet. In this section, we will investigate how the changes of prices in hashbrown affect the composition of cost minimum diet for Female 19-30.

```
[24]: group = "F 19-30"
q = np.zeros((9,50))
i = 0
for x in [0.15,0.17,0.19,0.21,0.23,0.25,0.27,0.29,0.31]:
    p["Hashbrowns"] = x
    q[i] = solve_subsistence_problem(A_limit, p, b_limit, group, tol=0).x
    i += 1
```

```
[25]: quantity_sensitive = pd.DataFrame(q, columns = A.columns)
quantity_sensitive["Hashbrown price"] = [0.15,0.17,0.19,0.21,0.23,0.25,0.27,0.
↳29,0.31]
quantity_sensitive = quantity_sensitive.set_index(["Hashbrown price"])
quantity_sensitive
```

```
[25]: Food Item      Vegetable Fried Rice      Korean Beefless Bulgogi \
Hashbrown price
0.15                3.754970e-10                6.421126e-11
0.17                4.739955e-10                7.060473e-11
0.19                6.134449e-10                9.287236e-11
0.21                7.741999e-10                1.090260e-10
0.23                8.980235e-10                7.888698e-11
```

0.25	3.568153e-13	1.561630e-13
0.27	1.132265e-09	6.169224e-10
0.29	3.710399e-11	1.853231e-11
0.31	4.263773e-11	2.089009e-11

Food Item	Cheese & Green Chile Tamales	Stir Fried Garlicky Cabbage \
Hashbrown price		
0.15	3.049096e-10	1.076814e-10
0.17	3.211451e-10	1.179498e-10
0.19	4.293725e-10	1.806748e-10
0.21	6.269487e-10	2.672743e-10
0.23	1.041831e-09	3.718993e-10
0.25	3.797828e-13	2.449301e-13
0.27	3.743418e-10	5.930639e-10
0.29	1.693211e-11	1.784818e-11
0.31	1.864990e-11	1.981573e-11

Food Item	Vegetarian Meatless Cheeseburger Pizza \
Hashbrown price	
0.15	1.769973e-10
0.17	1.887255e-10
0.19	2.534314e-10
0.21	3.689682e-10
0.23	6.061376e-10
0.25	2.605312e-13
0.27	3.621826e-10
0.29	1.429685e-11
0.31	1.585445e-11

Food Item	Roasted Garlic & Pesto Pizza with Deep Fried Crust \
Hashbrown price	
0.15	1.694739e-10
0.17	1.892841e-10
0.19	2.716969e-10
0.21	3.878120e-10
0.23	5.299319e-10
0.25	2.657340e-13
0.27	6.050553e-10
0.29	1.626216e-11
0.31	1.829760e-11

Food Item	Chickenless Crispy Tenders \
Hashbrown price	
0.15	1.721178e-10
0.17	1.854067e-10
0.19	2.577268e-10
0.21	3.080556e-10

0.23	1.921002e-10
0.25	2.725862e-13
0.27	1.172953e-09
0.29	3.220031e-11
0.31	3.590720e-11

Food Item	Bulgogi Beef Fried Rice with Kimchi \
Hashbrown price	
0.15	1.069652e-10
0.17	1.202896e-10
0.19	1.966544e-10
0.21	3.386038e-10
0.23	6.441333e-10
0.25	2.842992e-13
0.27	3.875756e-10
0.29	1.697939e-11
0.31	1.869439e-11

Food Item	Bulgur Pilaf with Butternut Squash & Feta Cheese \
Hashbrown price	
0.15	5.146892e-10
0.17	5.685796e-10
0.19	7.818900e-10
0.21	1.118482e-09
0.23	1.683162e-09
0.25	7.303514e-13
0.27	1.284066e-09
0.29	4.063592e-11
0.31	4.546055e-11

Food Item	Chicken Burrito Bowl ...	Cauliflower Gnocchi \
Hashbrown price	...	
0.15	1.980210e-10 ...	1.768159e-10
0.17	2.069811e-10 ...	2.027096e-10
0.19	2.831567e-10 ...	2.999630e-10
0.21	4.252206e-10 ...	3.498102e-10
0.23	7.274339e-10 ...	1.921259e-11
0.25	2.763122e-13 ...	1.170981e-14
0.27	3.009679e-10 ...	5.769638e-10
0.29	1.417188e-11 ...	1.082867e-12
0.31	1.561189e-11 ...	1.441289e-12

Food Item	Gluten Free Mac & Cheese \
Hashbrown price	
0.15	3.375435e-10
0.17	3.552339e-10
0.19	4.773999e-10

0.21	7.005643e-10
0.23	1.169029e-09
0.25	4.193161e-13
0.27	4.000426e-10
0.29	1.845408e-11
0.31	2.031228e-11

Food Item	Steamed Pork & Ginger Soup Dumplings	Sriracha Shrimp Bowl \
Hashbrown price		
0.15	2.450299e-10	2.170020e-10
0.17	2.578127e-10	2.270816e-10
0.19	3.489896e-10	3.034557e-10
0.21	5.153229e-10	4.427065e-10
0.23	8.662901e-10	7.352948e-10
0.25	2.903526e-13	2.441743e-13
0.27	2.709460e-10	2.131325e-10
0.29	1.364825e-11	1.077000e-11
0.31	1.507786e-11	1.187838e-11

Food Item	Chicken-less Mandarin Orange Morsels	Pizza Parlano \
Hashbrown price		
0.15	8.622131e-12	8.816743e-10
0.17	8.803065e-12	9.841853e-10
0.19	9.277618e-12	1.225335e-09
0.21	1.004634e-11	1.608254e-09
0.23	2.020125e-11	2.343005e-09
0.25	1.263244e-13	7.177420e-13
0.27	4.416492e-10	7.662141e-10
0.29	1.558481e-11	2.970232e-11
0.31	1.757412e-11	3.320601e-11

Food Item	Outside-In Stuffed Gnocchi	Cuban Style Citrus Garlic Bowl \
Hashbrown price		
0.15	1.025162e-10	3.371141e-10
0.17	1.211800e-10	3.515317e-10
0.19	1.589107e-10	4.614796e-10
0.21	1.940582e-10	6.588924e-10
0.23	1.797589e-10	1.071072e-09
0.25	1.416482e-13	3.299418e-13
0.27	5.237161e-10	2.766895e-10
0.29	1.425029e-11	1.452221e-11
0.31	1.624664e-11	1.610743e-11

Food Item	Honey Walnut Shrimp	Chipotle Vegetable Quesadillas
Hashbrown price		
0.15	4.172677e-10	5.638754e-10
0.17	4.464749e-10	5.989874e-10

0.19	6.314455e-10	7.930628e-10
0.21	9.713002e-10	1.144533e-09
0.23	1.697064e-09	1.879574e-09
0.25	5.936926e-13	6.927135e-13
0.27	6.093280e-10	7.455733e-10
0.29	3.004062e-11	3.268968e-11
0.31	3.322917e-11	3.610960e-11

[9 rows x 50 columns]

```
[26]: for col in quantity_sensitive.columns:
      small = True
      for x in quantity_sensitive[col]:
          if x > 0.1:
              small = False
      if small == True:
          quantity_sensitive = quantity_sensitive.drop(columns = col)
quantity_sensitive
```

```
[26]: Food Item      Hashbrowns  Mini Beef Tacos  Mandarin Orange Chicken \
Hashbrown price
0.15      4.285419e+00      4.660403e-09      2.225440
0.17      4.285419e+00      8.744787e-09      2.225440
0.19      4.285419e+00      1.696839e-08      2.225440
0.21      4.285419e+00      3.814691e-08      2.225440
0.23      4.285418e+00      1.426116e-07      2.225440
0.25      4.285419e+00      4.185542e-10      2.225440
0.27      1.682780e-06      2.356218e+00      2.746268
0.29      1.758869e-08      2.356219e+00      2.746269
0.31      1.008606e-08      2.356219e+00      2.746269
```

Food Item	Mexican Style Roasted Corn
Hashbrown price	
0.15	4.297828
0.17	4.297828
0.19	4.297828
0.21	4.297828
0.23	4.297828
0.25	4.297828
0.27	2.694528
0.29	2.694527
0.31	2.694527

```
[27]: for col in quantity_sensitive.columns:
      plt.plot(quantity_sensitive.index, quantity_sensitive[col], label = col)
      plt.legend(fontsize = 'small')
plt.xlabel("Prices of Hashbrown (per serving)")
```

```
plt.ylabel("Optimal quantities (serving)")
plt.title("Change in composition of diet with change in prices of hashbrown")
```

[27]: Text(0.5, 1.0, 'Change in composition of diet with change in prices of hashbrown')

