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MATH 566 Discrete Optimization

Homework 1

In order to find the recommended daily intake of nutrients, I used the website <https://fnic.nal.usda.gov/fnic/interactiveDRI/>. This website gives recommended daily intake based on height, weight, age, gender, and activity level. The following table summarizes the recommended daily intake for the professor.

Nutrient	Daily Requirement
Calories	2779 kcal
Carbohydrates	383 grams
Fiber	38 grams
Protein	60 grams
Sodium	1.5 grams

I then went to Walmart to do some grocery shopping. The following table summarizes the nutritional content and cost of 15 different foods.

Food	Calories	Carbohydrates	Fiber	Protein	Sodium	Cost
Gatorade (20 oz)	125	35 g	0 g	0 g	0.275 g	\$0.75
Peanut Butter (32 g)	190	7 g	2 g	7 g	0.130 g	\$0.13
Apple sauce (128 g)	110	27 g	1 g	0 g	0 g	\$0.34
Blackberry Jam (20 g)	50	13 g	0 g	0 g	0 g	\$0.13
Frozen Waffles (70 g)	190	27 g	1 g	4 g	0.360 g	\$0.48
Granola Bar	100	18 g	1 g	2 g	0.06 g	\$0.17
Corn (125 g)	60	9 g	2 g	2 g	0.2 g	\$0.21
Green Beans (120 g)	20	4 g	2 g	1 g	0.38 g	\$0.21
Peas (125 g)	70	12 g	3 g	4 g	0.37 g	\$0.21
FiberOne Cereal (1/2 cup)	60	25 g	14 g	2 g	0.105 g	\$0.25
Cocunut Milk (80 ml)	120	2 g	0 g	1 g	0.025 g	\$0.42
Tortilla (49 g)	140	24 g	1 g	4 g	0.44 g	\$0.26
Turkey Breast (52 g)	80	1 g	0 g	8 g	0.69 g	\$0.50
Roast Beef (56 g)	60	0 g	0 g	11 g	0.52 g	\$1.15
Hamburger Buns (1.6 oz)	150	25 g	1 g	4 g	0.025 g	\$0.29

The following model for APMonitor was used to solve this linear program.

Model Diet

Variables

$x[1:15] = 0, \geq 0$

End Variables

Equations

$125*x[1] + 190*x[2] + 110*x[3] + 50*x[4] + 190*x[5] + 100*x[6] + 60*x[7]$
 $+ 20*x[8] + 70*x[9] + 60*x[10] + 120*x[11] + 140*x[12] + 80*x[13]$
 $+ 60*x[14] + 150*x[15] \geq 2779$
 $35*x[1] + 7*x[2] + 27*x[3] + 13*x[4] + 27*x[5] + 18*x[6] + 9*x[7]$
 $+ 4*x[8] + 12*x[9] + 25*x[10] + 2*x[11] + 24*x[12] + 1*x[13] + 25*x[15] \geq 383$
 $2*x[2] + x[3] + x[5] + x[6] + 2*x[7] + 2*x[8] + 3*x[9] + 14*x[10]$
 $+ x[12] + x[15] \geq 38$

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7*x[2] + 4*x[5] + 2*x[6] + 2*x[7] + 1*x[8] + 4*x[9] + 2*x[10] + x[11]
+ 4*x[12] + 8*x[13] + 11*x[14] + 4*x[15] >= 60
0.275*x[1] + 0.13*x[2] + 0.36*x[5] + 0.06*x[6] + 0.2*x[7] + 0.38*x[8]
+ 0.37*x[9] + 0.105*x[10] + 0.025*x[11] + 0.44*x[12] + 0.69*x[13]
+ 0.52*x[14] + 0.025*x[15] >= 1.5*1.4
minimize 0.75*x[1] + 0.13*x[2] + 0.34*x[3] + 0.13*x[4] + 0.48*x[5]
+ 0.17*x[6] + 0.21*x[7] + 0.21*x[8] + 0.21*x[9] + 0.25*x[10]
+ 0.42*x[11] + 0.26*x[12] + 0.5*x[13] + 1.15*x[14] + 0.29*x[15]

```

End Equations

End Model

The solution that APMonitor found was

Objective Value = 3.95434986

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diet.slk_1 = 0.0
diet.slk_2 = 0.0
diet.slk_3 = 0.0
diet.slk_4 = 12.1406002045
diet.slk_5 = 0.0
diet.x[10] = 0.752789795399
diet.x[11] = 0.0
diet.x[12] = 0.859616100788
diet.x[13] = 0.0
diet.x[14] = 0.0
diet.x[15] = 0.0
diet.x[1] = 0.0
diet.x[2] = 4.66463518143
diet.x[3] = 0.0
diet.x[4] = 0.0
diet.x[5] = 0.0
diet.x[6] = 17.2720603943
diet.x[7] = 0.0
diet.x[8] = 0.0
diet.x[9] = 0.0

```

This means that for \$3.95 a day, the professor should eat .75 servings of FiberOne cereal, .86 tortillas, 4.66 servings of peanut butter and 17.27 granola bars. Over the course of a year this would cost \$1441.75, and the professor would eat 273.75 servings of FiberOne cereal, 313.9 tortillas, 1700.9 servings of peanut butter, and 6303.55 granola bars.

The following table summarizes my daily recommended intake of nutrients.

Nutrient	Daily Requirement
Calories	3397 kcal
Carbohydrates	467 grams
Fiber	38 grams
Protein	73 grams
Sodium	1.5 grams

In order to solve this linear program for my daily requirements, I used the following model.

Model Diet

Variables

$x[1:15] = 0, \geq 0$

End Variables

Equations

```
125*x[1] + 190*x[2] + 110*x[3] + 50*x[4] + 190*x[5] + 100*x[6] + 60*x[7]
+ 20*x[8] + 70*x[9] + 60*x[10] + 120*x[11] + 140*x[12] + 80*x[13]
+ 60*x[14] + 150*x[15] >= 3397
35*x[1] + 7*x[2] + 27*x[3] + 13*x[4] + 27*x[5] + 18*x[6] + 9*x[7]
+ 4*x[8] + 12*x[9] + 25*x[10] + 2*x[11] + 24*x[12] + 1*x[13] + 25*x[15] >= 467
2*x[2] + x[3] + x[5] + x[6] + 2*x[7] + 2*x[8] + 3*x[9] + 14*x[10]
+ x[12] + x[15] >= 38
7*x[2] + 4*x[5] + 2*x[6] + 2*x[7] + 1*x[8] + 4*x[9] + 2*x[10] + x[11]
+ 4*x[12] + 8*x[13] + 11*x[14] + 4*x[15] >= 73
0.275*x[1] + 0.13*x[2] + 0.36*x[5] + 0.06*x[6] + 0.2*x[7] + 0.38*x[8]
+ 0.37*x[9] + 0.105*x[10] + 0.025*x[11] + 0.44*x[12] + 0.69*x[13]
+ 0.52*x[14] + 0.025*x[15] >= 1.5
minimize 0.75*x[1] + 0.13*x[2] + 0.34*x[3] + 0.13*x[4] + 0.48*x[5]
+ 0.17*x[6] + 0.21*x[7] + 0.21*x[8] + 0.21*x[9] + 0.25*x[10]
+ 0.42*x[11] + 0.26*x[12] + 0.5*x[13] + 1.15*x[14] + 0.29*x[15]
```

End Equations

End Model

The solution to this linear program was

Objective Value = 4.76215906

diet.slk_1 = 0.0

diet.slk_2 = 0.0

diet.slk_3 = 0.0

diet.slk_4 = 12.5778903961

diet.slk_5 = 0.643295824528

diet.x[10] = 0.260098397732

diet.x[11] = 0.0

diet.x[12] = 0.0

diet.x[13] = 0.0

diet.x[14] = 0.0

diet.x[15] = 0.0

diet.x[1] = 0.0

diet.x[2] = 5.44681596756

diet.x[3] = 0.0

diet.x[4] = 0.0

diet.x[5] = 0.0

diet.x[6] = 23.4649906158

diet.x[7] = 0.0

diet.x[8] = 0.0

diet.x[9] = 0.0

This means that for \$4.76 a day, I should eat .26 servings of FiberOne cereal, 5.45 servings of peanut butter, and 23.465 granola bars. Over the course of a year this would cost \$1738.19 and I would eat 94.9 servings of FiberOne cereal, 1989.25 servings of peanut butter and 8564.725 granola bars.