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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, >=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] >= 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] >= 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] >= 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] >= 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
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.

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, >=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.