**Problem 2: A mixture problem**

Part A

i)

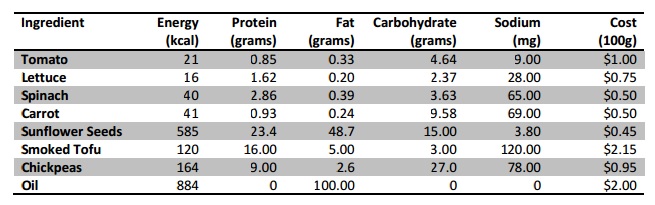
Each ingredient of the 8 ingredients in the salad will be assigned as if it is an array. The optimal solution will be a combination of the ingredients. Variables are:

* T = Tomato
* L = Lettuce
* S = Spinach
* C = Carrot
* SS = Sunflower Seeds
* ST = Smoked Tofu
* CP = Chickpeas
* O = Oil

Additionally, each ingredient will have an assigned variable for nutritional value as follows:

* P = Protein
* F = Fat
* C = Carbohydrates
* S = Sodium
* LG = Leafy Greens

Given nutritional content of the ingredients:



Our goal is to minimize the amount of calories but still meet a specific nutritional requirement. Each salad must contain:

* At least 2 but no more than 8 ingredients.
* At least 15 grams of protein
* At least 2 and at most 8 grams of fat
* At least 4 grams of carbohydrates
* At most 200mg of sodium
* At least 40% leafy greens by mass

Given the provided requirements for a salad we can derive some constraints for our linear program:

* P >= 15
* 2 <= F <=8
* C >= 4
* S <= .2
* LG >= .4(mass)

ii)

Using LINDO, we can determine the optimal solution for this program with the following code:

MIN 21T + 16L + 40S + 41C + 585SS + 120ST + 164CP + 884O

ST

0.85T + 1.62L + 2.86S + 0.93C + 23.4SS + 16ST + 9CP >= 15

0.33T + 0.20L + 0.39S + 0.24C + 48.7SS + 5ST + 2.6CP + 100O >= 2

0.33T + 0.20L + 0.39S + 0.24C + 48.7SS + 5ST + 2.6CP + 100O <= 8

4.64T + 2.37L + 3.63S + 9.58C + 15SS + 3ST + 27CP >= 4

9T + 28L + 65S + 69C + 3.8SS + 120ST + 78CP <= 200

0.4L + 0.4S 0.6T

0.6C

0.6SS

0.6ST

0.6CP

0.6O

>= 0

T >= 0

L >= 0

S >= 0

C >= 0

SS >= 0

ST >= 0

CP >= 0

O >= 0

END

Results of the code will be attached to this report titled Problem 2-A Lindo Results.txt.

iii)

The lowest calorie salad solution:

|  |  |  |  |
| --- | --- | --- | --- |
| Ingredient | Calories | Cost ($) | Nutrition |
| Lettuce (1.220836 units) | 20 | $0.92 | 1.98g Protein  .24g Fat  2.89g Carbohydrates  34mg Sodium |
| Smoked Tofu (.813890 units) | 98 | $1.75 | 13.02g Protein  4.07g Fat  2.44g Carbohydrates  98mg Sodium |
| Totals: |  |  |  |
| Lettuce and Smoked Tofu | 118 | $2.67 | 15g Protein  4.31g Fat  5.33g Carbohydates  132mg Sodum |

As you can see, this combination meets all of our requirements outlined above.

Part B

i)

The goal for this problem is to minimize cost associated with the salad, while still meeting the minimum nutritional requirements. We will reuse the same variables and nutritional table as in Part A for this problem, so the constraints will be:

* P >= 15
* 2 <= F <=8
* C >= 4
* S <= .2
* LG >= .4(mass)

ii)

Again we will be using LINDO for this solution:

MIN 1T + 0.75L + 0.5S + 0.5C + 0.45SS + 2.15ST + .95CP + 2O

ST

0.85T + 1.62L + 2.86S + 0.93C + 23.4SS + 16ST + 9CP >= 15

0.33T + 0.20L + 0.39S + 0.24C + 48.7SS + 5ST + 2.6CP + 100O >= 2

0.33T + 0.20L + 0.39S + 0.24C + 48.7SS + 5ST + 2.6CP + 100O <= 8

4.64T + 2.37L + 3.63S + 9.58C + 15SS + 3ST + 27CP >= 4

9T + 28L + 65S + 69C + 3.8SS + 120ST + 78CP <= 200

0.4L + 0.4S - 0.6T - 0.6C - 0.6SS - 0.6ST - 0.6CP - 0.6O >= 0

T >= 0

L >= 0

S >= 0

C >= 0

SS >= 0

ST >= 0

CP >= 0

O >= 0

END

Results will be attached to this report as Problem 2-B Lindo Results.txt.

iii)

Given the results, the following is the solution for a low cost salad:

|  |  |  |  |
| --- | --- | --- | --- |
| Ingredient | Calories | Cost ($) | Nutrition |
| Spinach (1.525128 units) | 61 | $0.76 | 4.36g Protein  0.60g Fat  5.54g Carbohydrates  99mg Sodium |
| Sunflower Seeds (0.103289 units) | 60 | $0.05 | 2.42g Protein  5.02g Fat  1.55g Carbohydrates  < 1mg Sodium |
| Chickpeas (0.913462 units) | 150 | $0.87 | 8.22g Protein  2.38g Fat  24.66g Carbohydrates  71mg Sodium |
| Totals: |  |  |  |
| Spinach, Sunflower Seeds, and Chickpeas | 270 | $1.68 | 15g Protein  8g Fat  31.75g Carbohydrates  171mg Sodium (rounded up) |

As we can see, these results meet our requirements for being low cost and also meeting the specified nutritional values.

Part C

i)