

What's For Dinner:

A Linear Analysis of Nutritional Data and an Application to Community Health

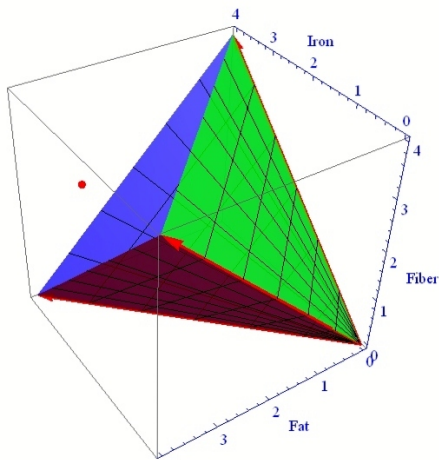
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Introduction

- Real World Applications of Linear Algebra
 - Our own project in Linear Algebra I, Fall 2010, involving three foods, three nutrients, and a \$5 college budget



Previous Studies

What's For
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Friedrich,
Garrett

- Stigler's Diet Problem

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 - Wheat flour, evaporated milk, cabbage, spinach, and navy beans for \$39.93 per year for one man

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 - Wheat flour, evaporated milk, cabbage, spinach, and navy beans for \$39.93 per year for one man
- Meal optimization in developing countries

Our Project

What's For
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- Community-based

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 - Housing Authority of the City of Asheville (HACA)

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- Eleven key nutrients

Our Budgets

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- Annual income information per family provided by HACA

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- \$12 per family for dinner, \$6 for breakfast and lunch

Our Nutrients

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- Recommended daily allowances (RDAs) of nutrients obtained through the USDA's 2010 Dietary Guidelines for Americans

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 - Maximized calories, protein, carbohydrates, and fiber and minimized total fat

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- Micronutrients:

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- Micronutrients:
 - Maximized calcium, potassium, vitamin A, vitamin C, and folate and minimized sodium

Our Adjusted Nutrient Ranges

What's For
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Children 4-18

Calories	1300-2100
Protein (grams)	32.5-157.5
Carbs (grams)	179-289
Fiber (grams)	15-35
Total Fat (grams)	36-81.5
Calcium (mg)	1000-1300
Potassium (mg)	4500-4700
Vitamin A (μg)	600-900
Vitamin C (μg)	45-75
Folate (μg)	300-400
Sodium (mg)	0-2300

Adults 18-30

Calories	1900-2300
Protein (grams)	47.5-172.5
Carbs (grams)	261.5-316.5
Fiber (grams)	15-35
Total Fat (grams)	52.5-89.5
Calcium (mg)	1000-1300
Potassium (mg)	4500-4700
Vitamin A (μg)	600-900
Vitamin C (μg)	45-75
Folate (μg)	300-400
Sodium (mg)	0-2300

Our Methods

What's For
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- Created a list of 132 foods and their constituent nutrients

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 - Breads and grains, breakfast cereals, vegetables, fruit, nuts and seeds, legumes, poultry, fish, beef, and dairy

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- Acquired current non-promotional prices for private label foods at Ingles Grocery Markets

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 - 14 locations within a 10 mile radius

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 - 14 locations within a 10 mile radius
 - Ingles prices are at or above discount grocery prices

Creating Meals

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- Maximizing foods and nutrients using *Mathematica*

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 - The “gap-fillers”: Instant oats and orange juice
 - Grand total: $\$1.71 \times 2 = \3.42

Meeting the RDAs

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$$\frac{1}{3}\mathbf{A} + \frac{1}{3}\mathbf{A} = \frac{2}{3}\mathbf{A} \quad \text{Adult RDA}$$

Calories	1267-1533
Protein (grams)	32-115
Carbs (grams)	174-211
Fiber (grams)	10-23
Total Fat (grams)	35-38.5
Calcium (mg)	667-867
Potassium (mg)	3000-3133
Vitamin A (μg)	400-600
Vitamin C (μg)	30-50
Folate (μg)	200-267
Sodium (mg)	0-1533

Our \$3.42 Breakfast

Calories	1267
Protein (grams)	38.7
Carbs (grams)	211
Fiber (grams)	19.8
Total Fat (grams)	38.5
Calcium (mg)	867
Potassium (mg)	3133
Vitamin A (μg)	450.3
Vitamin C (μg)	50
Folate (μg)	267
Sodium (mg)	372.6

What's in a Meal?: Lunch

What's For
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Ingredients

Brown Rice	19.5 oz.
Turkey	2.9 oz.
Mushrooms	9.2 oz.
Squash	1.9 oz.
Zucchini	9.2 oz.
Provolone	3 oz.
Kidney Beans	2.4 oz.
Cucumber	8 oz.
<i>Total Cost</i>	\$6.00

Nutrition Content

Calories	1267
Protein (grams)	73.1
Carbs (grams)	174
Fiber (grams)	23
Total Fat (grams)	36.4
Calcium (mg)	867
Potassium (mg)	3000
Vitamin A (μg)	428.1
Vitamin C (μg)	50
Folate (μg)	213.3
Sodium (mg)	1076.7

What's in a Meal?: Dinner

What's For
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Ingredients

Eggs	6
Mushrooms	10 oz.
Spinach	1.6 oz.
Black Beans	3.4 oz.
Cheddar Cheese	8 oz.
Chicken	4.8 oz.
Applesauce	11.5 oz.
Bananas	2.1 lbs.
<i>Total Cost</i>	\$10.04

Nutrition Content

Calories	2350.6
Protein (grams)	158.8
Carbs (grams)	293.7
Fiber (grams)	39.2
Total Fat (grams)	71
Calcium (mg)	1359.5
Potassium (mg)	6266.7
Vitamin A (μg)	990.1
Vitamin C (μg)	100
Folate (μg)	533.3
Sodium (mg)	2360.2

Total Nutritive Content

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$$2A + \frac{2}{3}K$$

Calories	4667-6000
Protein (grams)	117-450
Carbs (grams)	642-826
Fiber (grams)	40-93
Total Fat (grams)	129-233
Calcium (mg)	2666.7-3467
Potassium (mg)	12000-12533
Vitamin A (μg)	1600-2400
Vitamin C (μg)	120-200
Folate (μg)	800-1067
Sodium (mg)	0-6133

Our Daily Values

Calories	4885
Protein (grams)	271
Carbs (grams)	679
Fiber (grams)	82
Total Fat (grams)	146
Calcium (mg)	3094
Potassium (mg)	12400
Vitamin A (μg)	1869
Vitamin C (μg)	200
Folate (μg)	1013
Sodium (mg)	3810

State of the project

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- Succeeded in creating palatable meals high in nutrient content and low in cost

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- Our results vs. real world applications

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- Our results vs. real world applications
 - Nutrition content can be slightly compromised in order to exchange foods for palatability, while remaining within a set budget

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- Our results vs. real world applications
 - Nutrition content can be slightly compromised in order to exchange foods for palatability, while remaining within a set budget
- Difficulty in generating specific meals

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- Our results vs. real world applications
 - Nutrition content can be slightly compromised in order to exchange foods for palatability, while remaining within a set budget
- Difficulty in generating specific meals
 - Limited database

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- Our results vs. real world applications
 - Nutrition content can be slightly compromised in order to exchange foods for palatability, while remaining within a set budget
- Difficulty in generating specific meals
 - Limited database
 - Purchasable quantities of foods

Our Goals

What's For
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- Create a meal plan for one week for a family of four

Our Goals

What's For
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- Create a meal plan for one week for a family of four
- Pamphlets with meal plans and recipes

Our Goals

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- Create a meal plan for one week for a family of four
- Pamphlets with meal plans and recipes
- Workshop with HACA

Our Sources

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-  **The Cost of Subsistence**
George J. Stigler, *Journal of Farm Economics* , Vol. 27, No. 2 (May, 1945), pp. 303-314
-  **Dietary Guidelines for Americans 2010**
U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans*, 2010. 7th Edition, Washington, DC: U.S. Government Printing Office, December 2010.
-  **The Economics of Nutrition**
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Supplemental Nutrition Assistance Program (SNAP) Pre-Screening Eligibility Tool. U.S. Department of Agriculture, Food and Nutrition Services. Wed. 07 November 2011.
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Lanou, Amy J. "Proper Nutrition Restraints." Personal interview. 3 October 2011.
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-  **Nutritional Adaptations of Linear Programming for Planning Rural Development**
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