

# Recipe Recommender

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17 May 2019



# Problem Statement

**Say you really like a recipe...**

- Can a recommender be built to recommend similar recipes?

**Say you crave something delicious but not as healthy as you hoped...**

- Can the recommender be biased toward recommending healthy alternatives?

# Data (Recipe) Acquisition



EDAMAM

API Developer Portal

Nutrition Wizard

LOGIN

MENU

BUSINESS



## Nutrition Analysis API

Analyze any recipe or ingredient list

Automatic tagging for allergens and popular diets

Database of 700,000+ food items

SIGN UP

CONSUMER

## Find something to cook



quesadilla

Refine search by **Calories, Diet, Ingredients** ▾

FIND

## Recipe Search API

1.7+ million nutritionally analyzed recipes



## Analyze your meal

Tips

For example:

# Data (Recipe) Acquisition

Sample query:

```
nutrient_of_interest = 'CA' #calcium
qry = f'nutrients%5B{nutrient_of_interest}%5D={0}-{70}' #will look at recipes with 0-70 mg of calcium
meal = 'dinner' #will look at recipes with mealType = 'dinner'
url = f'https://api.edamam.com/search?q=&app_id={id_i}&app_key={key_i}&{qry}&dishType={meal}&from={0}&to={100}'
res = requests.get(url) #requesting information from the API
print(res.status_code) #checking the request was successful (if the value is not in the 400's and is in the 200's)
the_json = res.json() #placing the recipe data in json format
```

# Recipes that were Collected

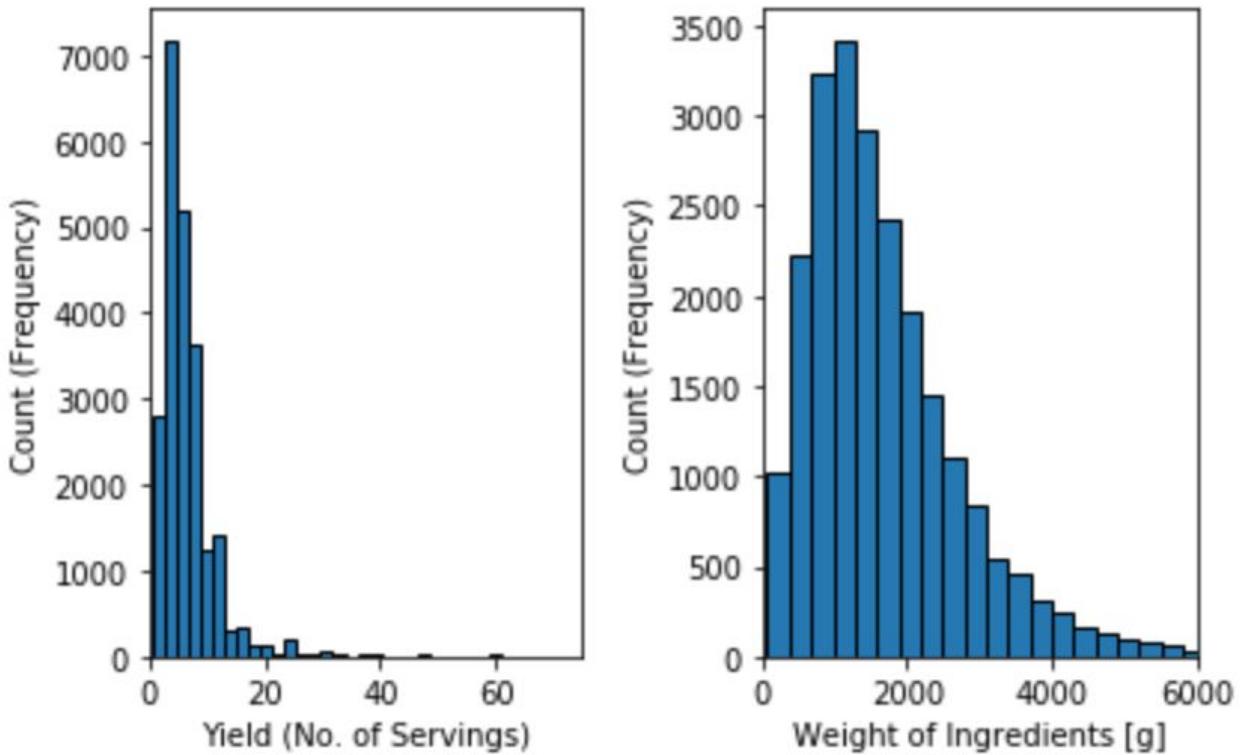
- Queries:
  - 28 nutrients: Range of values collected (from mass of 0 to total recommended value or more in some cases)
  - Five dish types per nutrient:
    - Breakfast
    - Lunch
    - Dinner
    - Dessert
    - Nibble
- Collected over 300,000 recipes
  - Dropped duplicates then had 42,777 recipes
  - Looked at 20 most common sources of recipe data then had 22,941 recipes

# Recipes that were Collected

- Nutrition score: sum of (max: 28):
  - Count of number of nutrients want to maximize in meal > 20% DV / serving
  - Count of number of nutrients want to minimize in meal < 20% DV / serving
    - Carbs, cholesterol, saturated fat, total fat, and sodium)
  - Count of number of nutrients in desired range in meal:
    - kcal < 33% DV
    - Monounsaturated fat:  $(0.3 * 2000 \text{ kcal/day}) / (9 \text{ kcal/g}) / 3 \text{ meals} = \text{want less than approx. } 22.2 \text{ g/serving}$
    - Polyunsaturated fat:  $(0.3 * 2000 \text{ kcal/day}) / (9 \text{ kcal/g}) / 3 \text{ meals} = \text{want less than approx. } 22.2 \text{ g/serving}$
    - Protein: between 20 - 33% DV (want good amount of protein but not too much in a meal)
  - Count of number of times sugar = 0 g and trans fat = 0 g

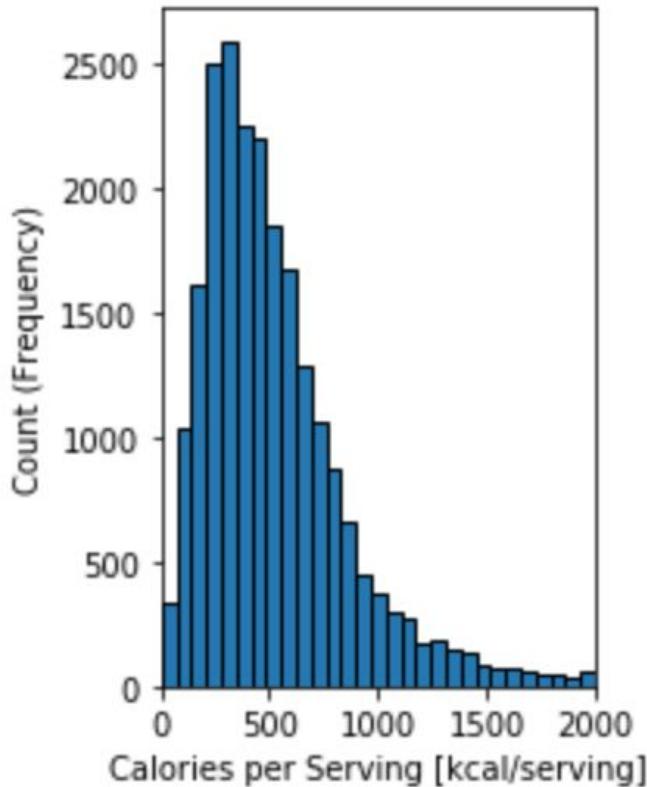
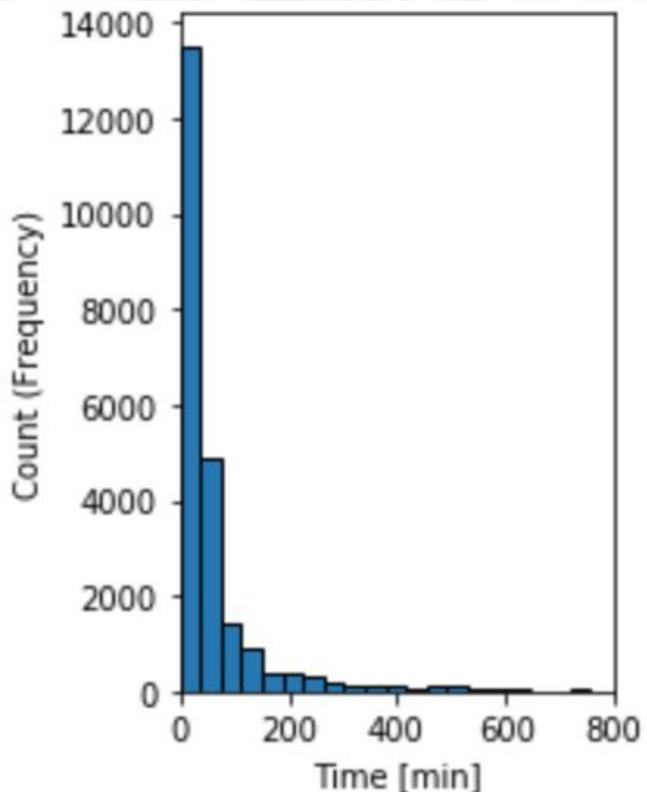
# Exploratory Data Analysis (EDA)

Nutrients:  
yield and  
weight of  
ingredients



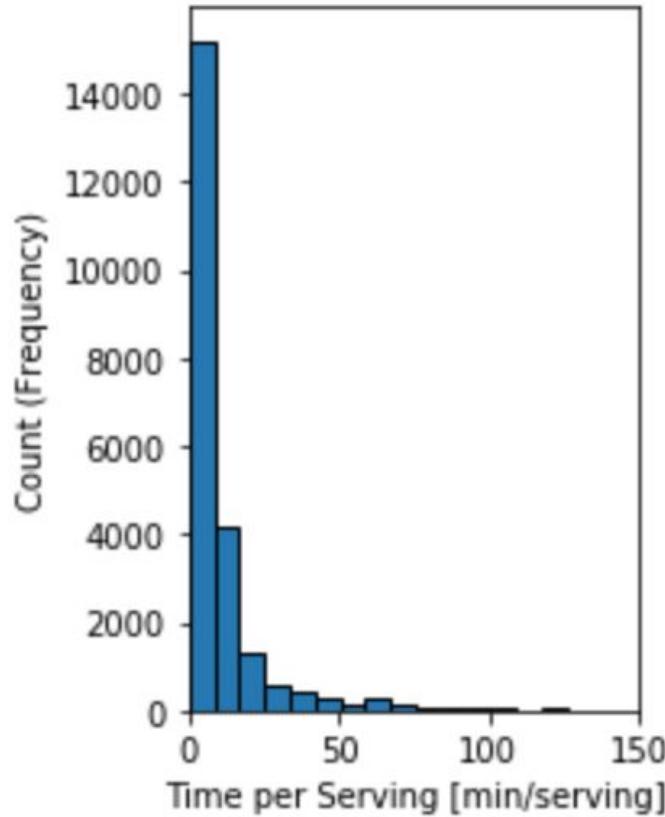
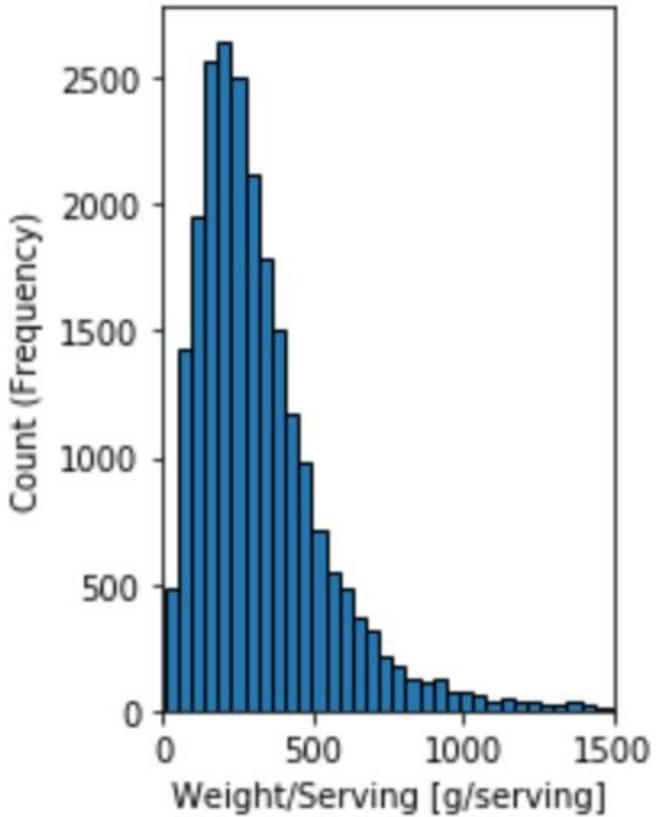
# EDA

Cook  
time and  
calories:



# EDA

Weight of ingredients per serving and cook time per serving



# EDA

Nutrients:

**Monounsaturated fat and**

**Polyunsaturated fat:** no more than 25% - 30% of daily calories

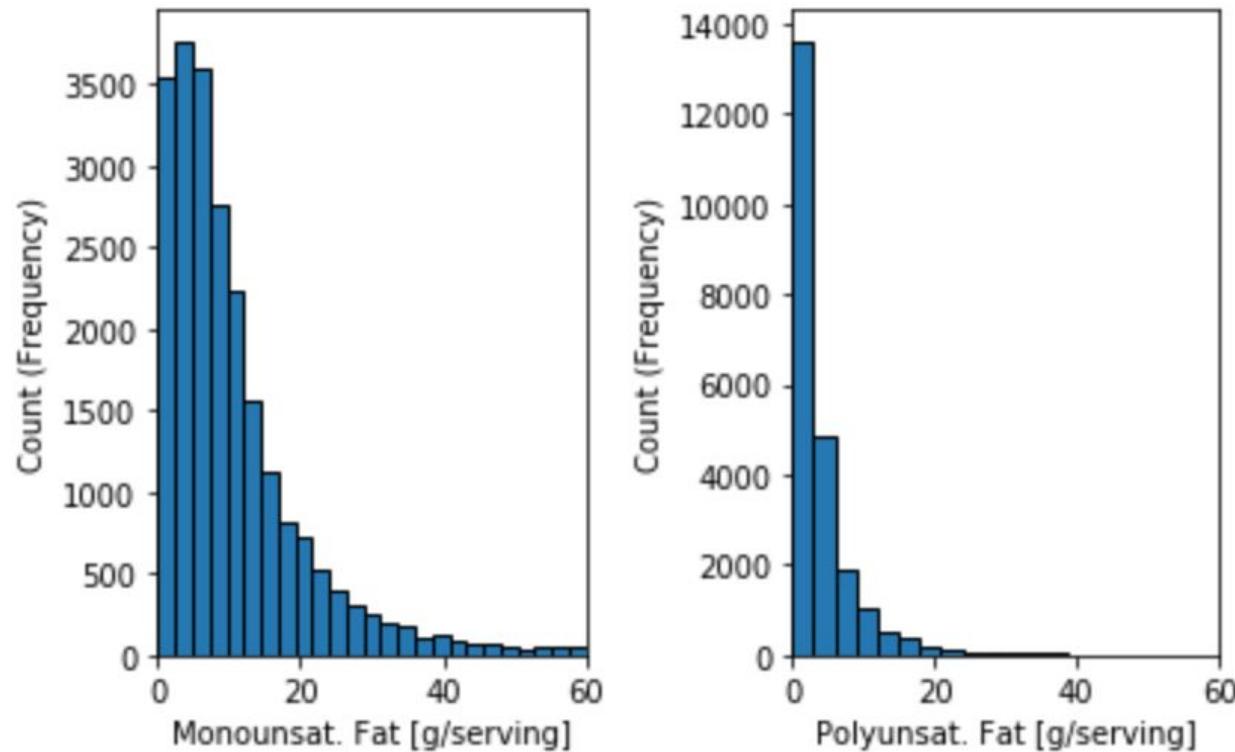
$0.30 * 2000 \text{ kcal/day} / (9 \text{ kcal/g}) = \text{approx. } 67 \text{ g /day}$

Source:

U.S. National Library of Medicine.

<https://medlineplus.gov/ency/patientinstructions/000785.htm>

Monounsaturated and Polyunsaturated Fat per Serving for Recipes Collected



# EDA

Nutrients:

**Saturated fat:** no more than 10% of daily calories

$$0.10 * 2000 \text{ kcal/day} / (9 \text{ kcal/g}) = \text{approx. } 22 \text{ g/day}$$

Source:

U.S. National Library of Medicine.

<https://medlineplus.gov/ency/patientinstructions/000785.htm>

**Sugar:** up to 38 g/day of added sugars

Sources:

U.S. Food and Drug Administration.

<https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/sugars.html>

UCSF's SugarScience.

<http://sugarscience.ucsf.edu/sugar-faq.html#.XNdZFutKhn4>

McMurray, Shandley.

<https://universityhealthnews.com/daily/nutrition/high-sugar-content-fruit-damaging-health-waistline/>

Steen, Juliette.

[https://www.huffingtonpost.com.au/2017/09/14/how-much-natural-sugar-should-we-eat-a-day\\_a\\_23208377/](https://www.huffingtonpost.com.au/2017/09/14/how-much-natural-sugar-should-we-eat-a-day_a_23208377/)

Lillis, Charlotte. <https://www.medicalnewstoday.com/articles/324673.php>

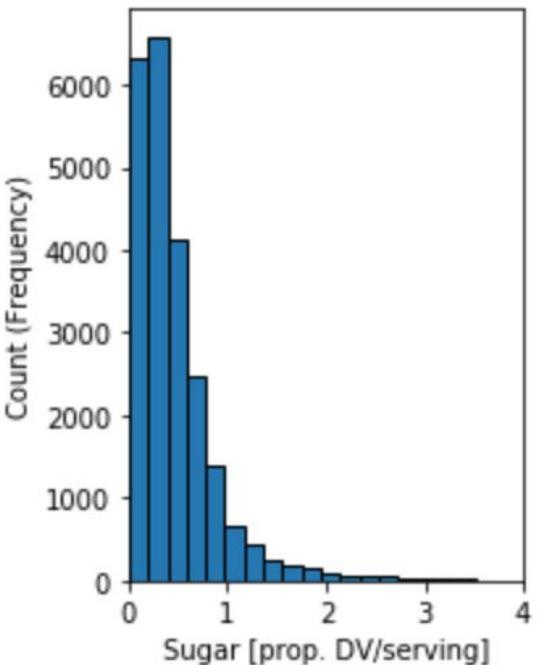
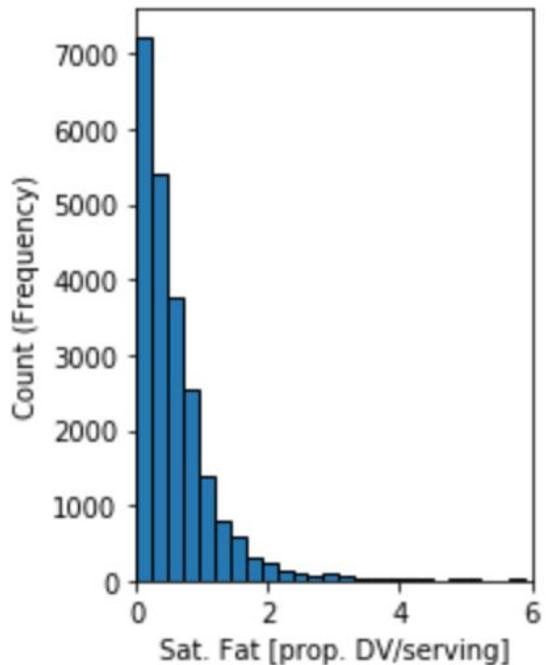


Photo by [amoon ra](#) on [Unsplash](#)

# EDA

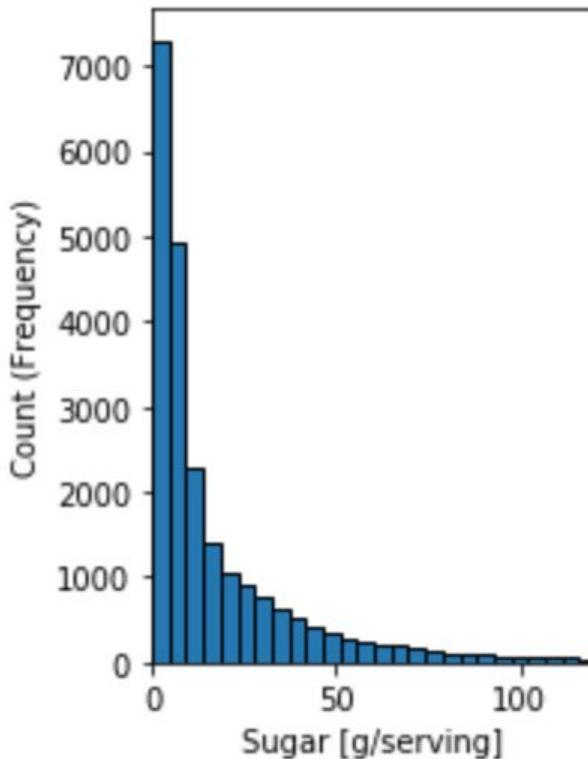
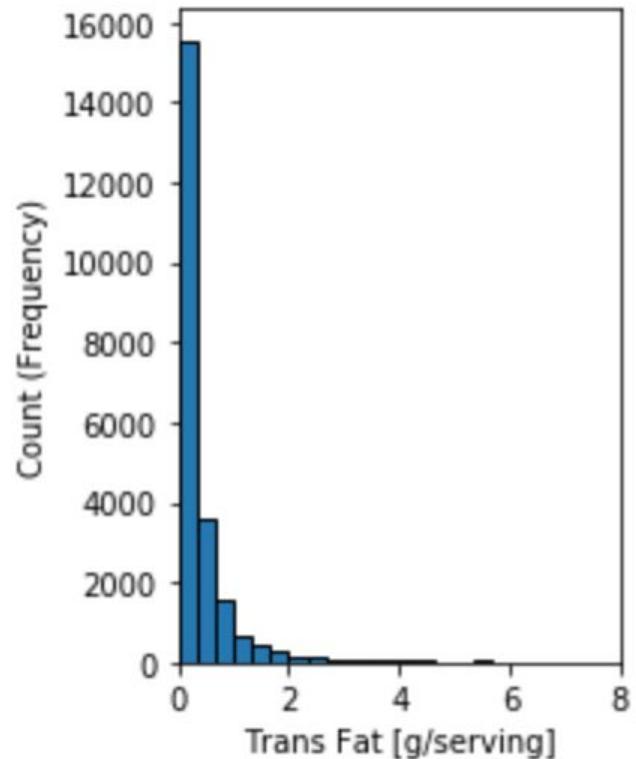
## Nutrients:

**Trans fat:** no more than 10% of daily calories  
 $0.10 * 2000 \text{ kcal/day} / (9 \text{ kcal/g}) = \text{approx. } 22 \text{ g /day}$

### Sources:

U.S. National Library of Medicine.  
<https://medlineplus.gov/ency/patientinstructions/000785.htm>

Caitlin Dewey,  
[https://www.washingtonpost.com/news/wonk/wp/2018/06/18/artificial-trans-fats-widely-linked-to-heart-disease-are-officially-banned/?utm\\_term=.1655f2600adf](https://www.washingtonpost.com/news/wonk/wp/2018/06/18/artificial-trans-fats-widely-linked-to-heart-disease-are-officially-banned/?utm_term=.1655f2600adf)



# EDA

Nutrients:

**Carbohydrates (carbs):** 225 - 325 grams/day recommended by Mayo Clinic

Source:  
Mayo Clinic Staff.

<https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/carbohydrates/art-20045705>

**Energy:** up to 3200 kcal (AKA: Calories) per day depending on sex, age, weight, activity level, etc.

Source:  
U.S. Institute of Medicine.  
<https://health.gov/dietaryguidelines/2015/guidelines/appendix-2/>

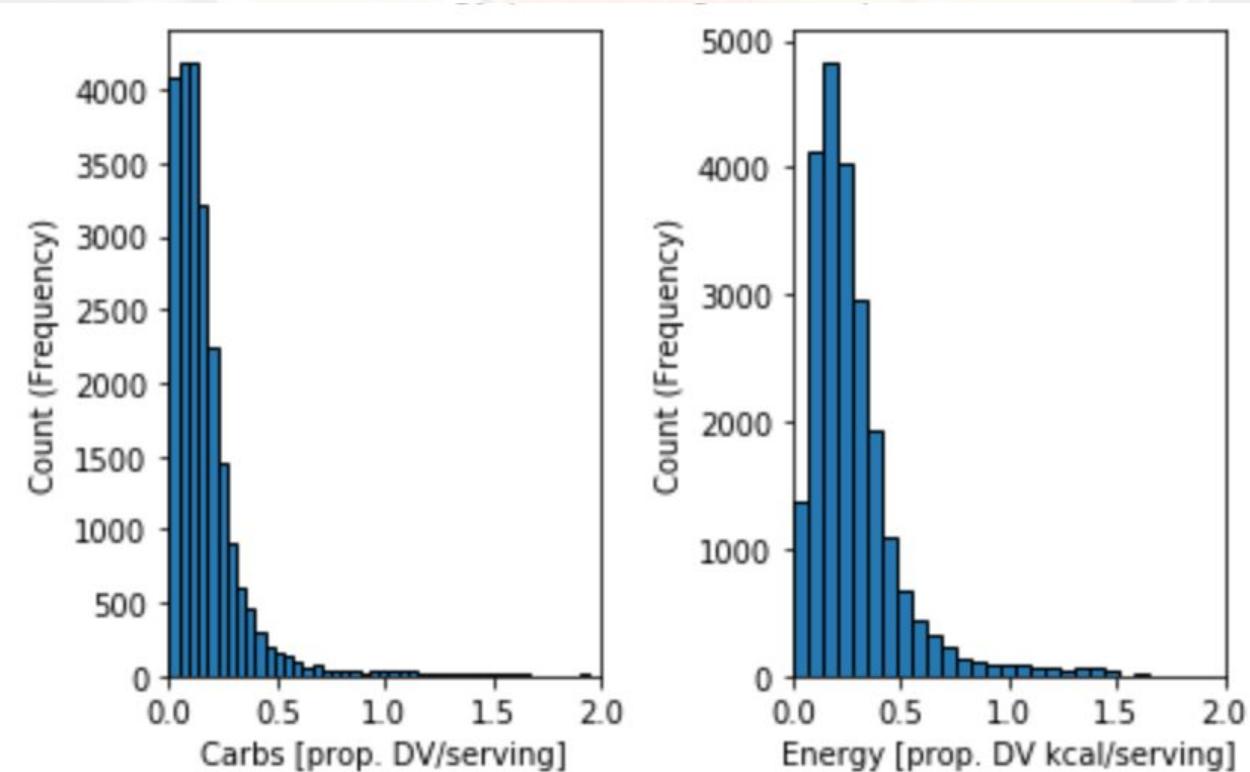


Photo by amoon ra on [Unsplash](#)

# EDA

Nutrients:

**Calcium:** 500 to 700 mg/day  
recommended by Harvard University

Source:  
Harvard Medical School.

[https://www.health.harvard.edu/staying-healthy/  
how-much-calcium-do-you-really-need](https://www.health.harvard.edu/staying-healthy/how-much-calcium-do-you-really-need)

**Vitamin D:** up to 20 mcg/day  
recommended (high levels if over 70 years of age)

Sources:  
U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/>  
Mayo Clinic Staff.  
<https://www.mayoclinic.org/drugs-supplements-vitamin-d/art-20363792>

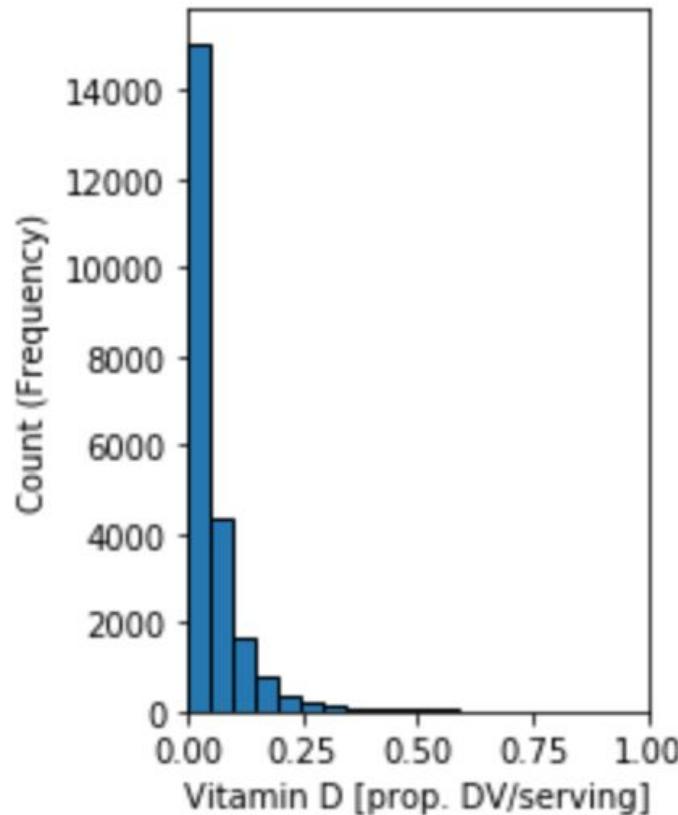
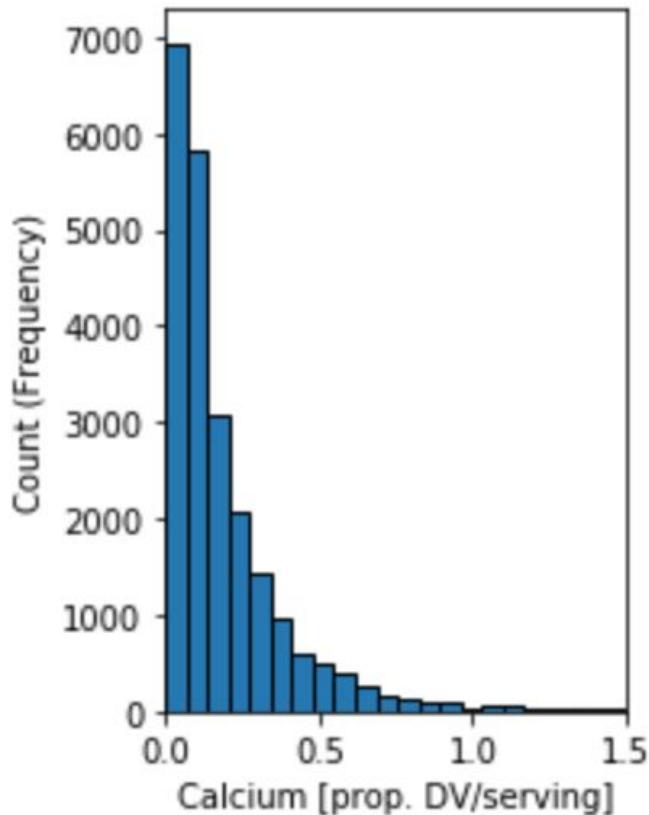


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# EDA

Nutrients:

**Cholesterol:** less than 300 mg/day recommended by FDA

Source:

U.S. Food and Drug Administration.

<https://www.accessdata.fda.gov/scripts/interactivenutritionfactslabel/cholesterol.html>

**Sodium:** less than 2,300 mg per day recommended

Sources:

U.S. Food and Drug Administration.

<https://www.fda.gov/food/nutrition-education-resources-and-materials/use-nutrition-facts-label-reduce-your-intake-sodium-your-diet>

Centers for Disease Control and Prevention.

[https://www.cdc.gov/salt/pdfs/sodium\\_dietary\\_guidelines.pdf](https://www.cdc.gov/salt/pdfs/sodium_dietary_guidelines.pdf)

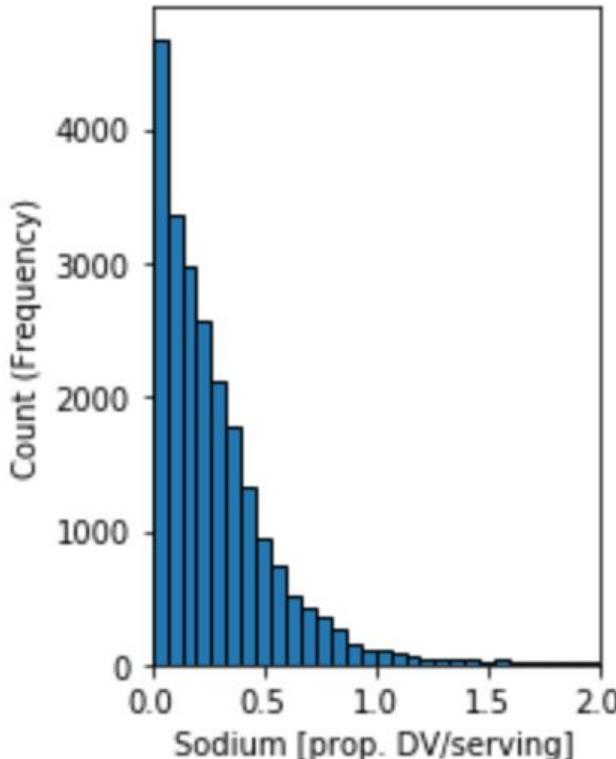
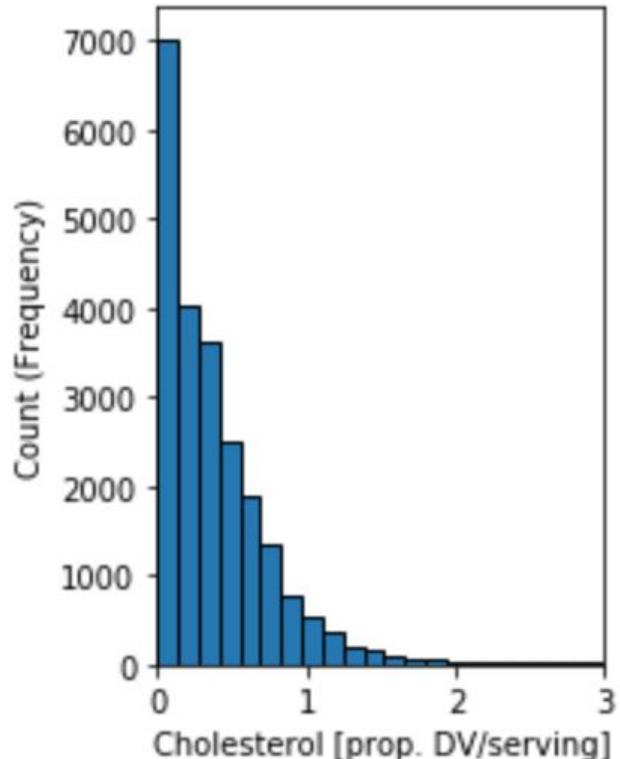


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# EDA

## Nutrients

**Iron:** up to 27 mg/day recommended  
(higher values recommended when pregnant or if have iron-deficiency anemia)

Source:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/Iron-HealthProfessional/>

**Folate/folic acid:** 400 micrograms (mcg) per day for adults recommended, and up to 800 mcg per day if female planning to become pregnant

Therefore, I'll look at recipes with up to 800 mcg of folate (in each serving).

Source:

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-folate/art-2036462>

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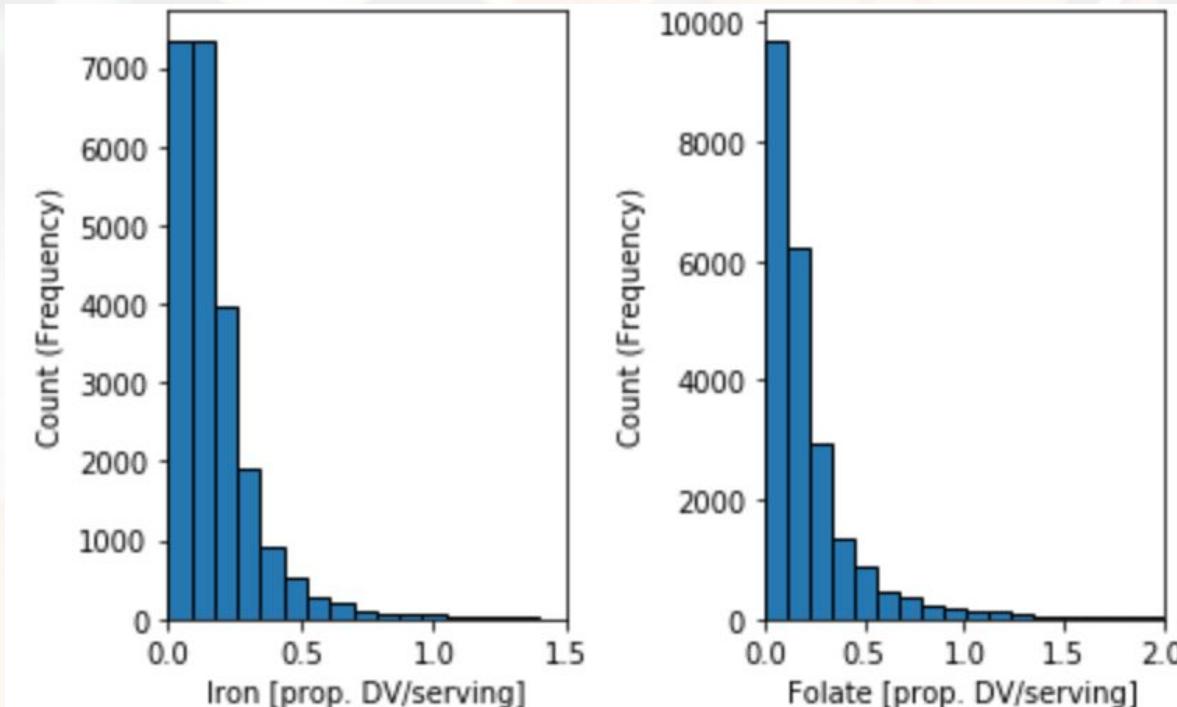


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# EDA

Nutrients:

**Fiber:** up to 38 g/day recommended  
(less for women than men and amount recommended differs depending on age)

Sources:

Mayo Clinic Staff.

<https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/high-fiber-foods/art-20050948>

WebMD, LLC.

<https://www.webmd.com/diet/eat-this-fiber-chart>

Lewin, Jo.

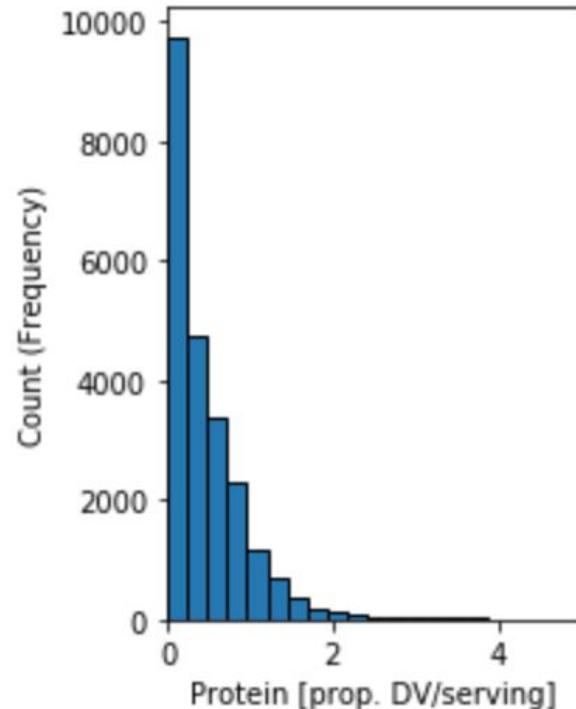
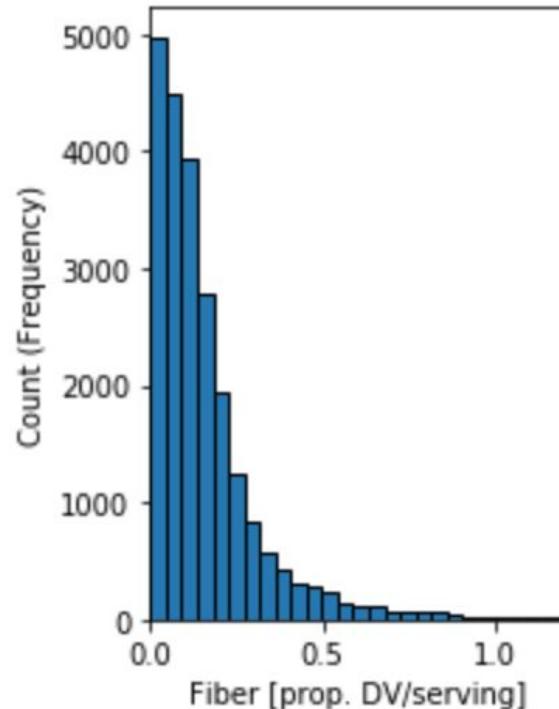
<https://www.medicalnewstoday.com/articles/321993.php>

**Protein:** 50 g/day based on a 2000 kcal/day diet (this value depends on caloric needs, etc.)

Source:

U.S. Food and Drug Administration.

<https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactLabel/protein.html>



# EDA

Nutrients:

**Potassium:** up to 3,400 mg per day (high levels if male over 19 years old or pregnant female)

Source:

U.S. National Institute of Health.

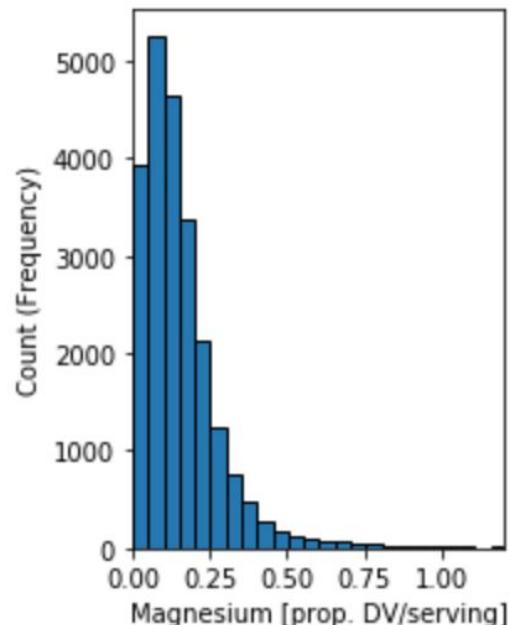
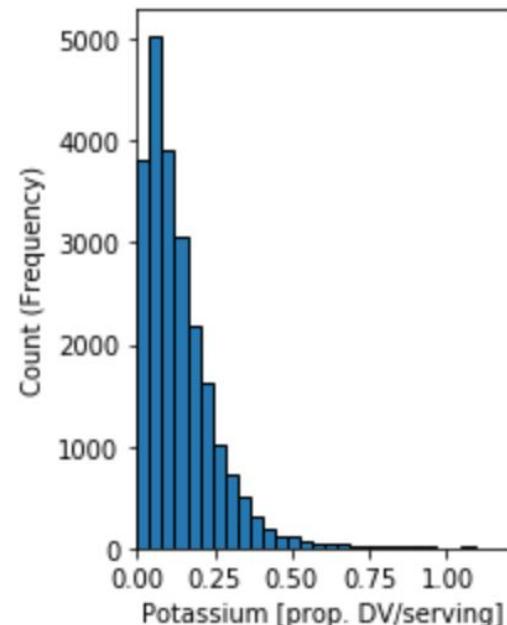
<https://ods.od.nih.gov/factsheets/Potassium-HealthProfessional/>

**Magnesium:** up to 420 mg per day (high levels if male over 14 years old or pregnant female)

Source:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/>



# EDA

Nutrients:

**Niacin (B3):** up to 18 mg/day (high values when women pregnant or lactating or men over 14 years of age)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/Niacin-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-niacin/art-20364984>

**Phosphorus:** up to 1,250 mg/day (high values if 9-18 years of age)

Sources:

U.S. National Library of Medicine.

<https://medlineplus.gov/ency/article/002424.htm>

U.S. National Academy of Sciences.

<https://www.ncbi.nlm.nih.gov/books/NBK109813/>

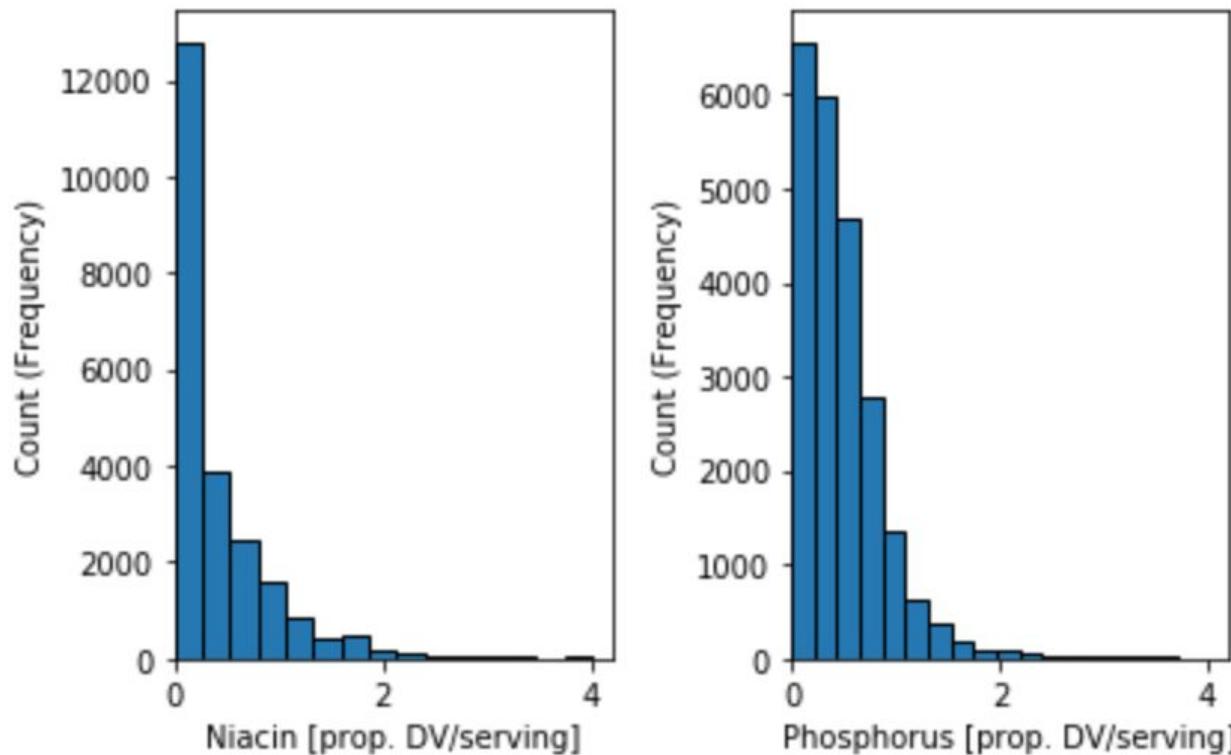


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# EDA

Nutrients:

**Riboflavin (B2):** up to 1.6 mg/day

recommended (high levels recommended when pregnant or breast-feeding)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/Riboflavin-HealthProfessional/>

Higdon, Jane, et al.

<https://lpi.oregonstate.edu/mic/vitamins/riboflavin>

**Thiamin (B1):** up to 1.4 mg/day

recommended (high values especially when pregnant or lactating)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/Thiamin-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-thiamin/art-20366430>

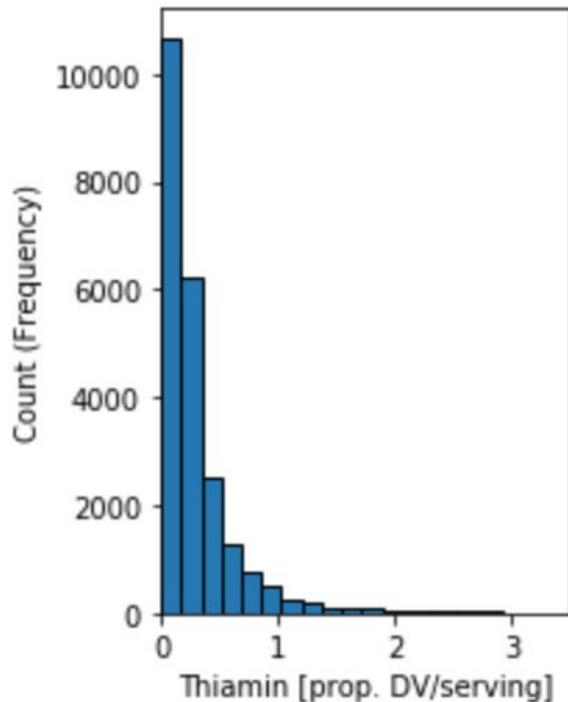
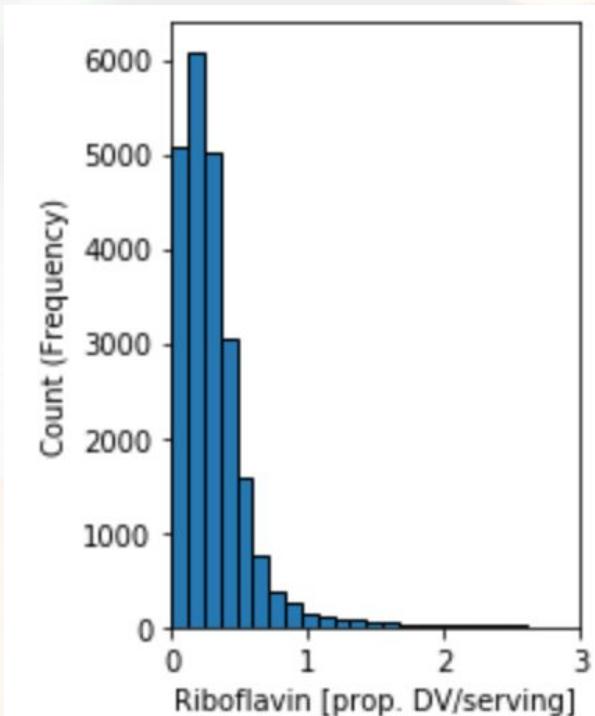


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# EDA

Nutrients:

**Vitamin A:** up to 1300 mcg/day

recommended (high values especially when lactating)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminA-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-vitamin-a/art-20365945>

**Vitamin C:** Up to 125 mg/day recommended (high values especially when pregnant or lactating or if a smoker (need 35 mg/day more if smoker))

Note: upper limit of ingestion: 2000 mg/day

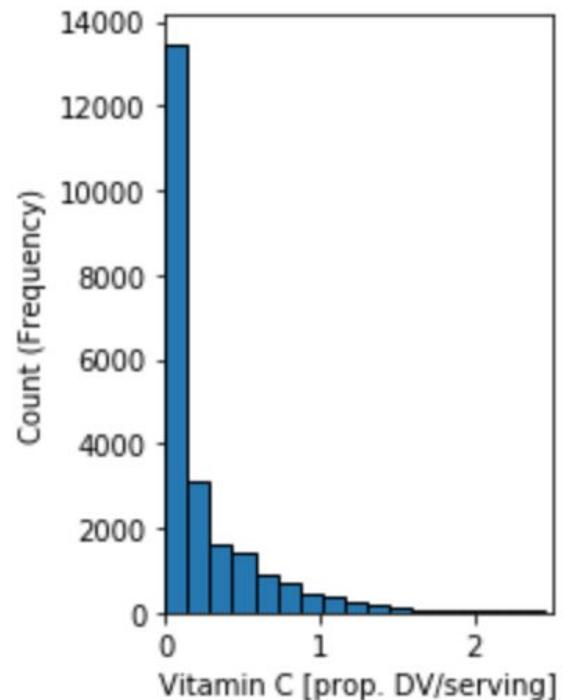
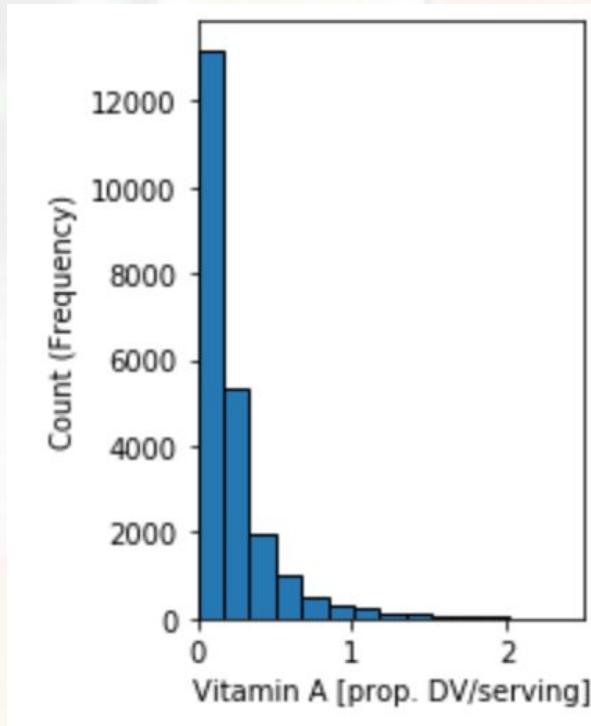
Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminC-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/expert-answers/vitamin-c/faq-20058030>



# EDA

Nutrients:

**Vitamin B6:** up to 2.0 mg/day

recommended (high values especially when pregnant or lactating)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminB6-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-vitamin-b6/art-20363468>

**Vitamin B12:** up to 2.8 mcg/day

recommended (high values especially when lactating)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminB12-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-vitamin-b12/art-20363663>

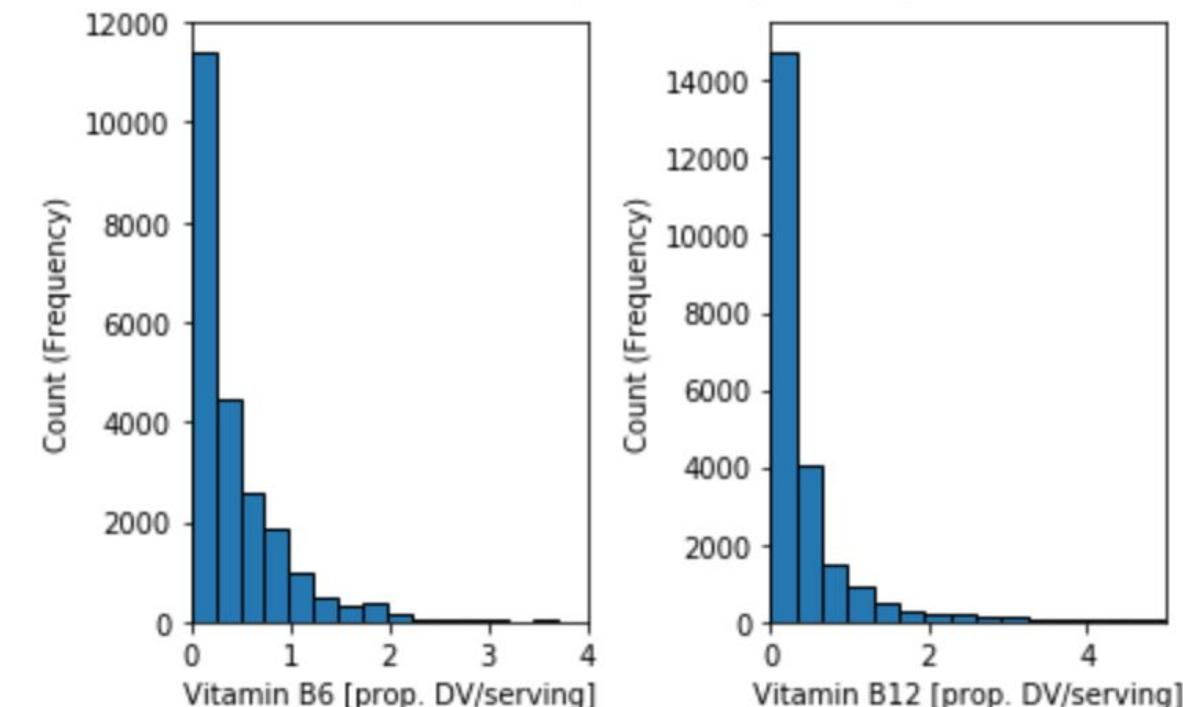


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# EDA

Nutrients:

**Vitamin E:** up to 19 mg/day recommended  
(high values especially when lactating)

Sources:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminE-HealthProfessional/>

Mayo Clinic Staff.

<https://www.mayoclinic.org/drugs-supplements-vitamin-e/art-2036414>

**Vitamin K:** 120 mcg/day adequate (high levels if male over 19 years old)

Source:

U.S. National Institute of Health.

<https://ods.od.nih.gov/factsheets/VitaminK-HealthProfessional/>

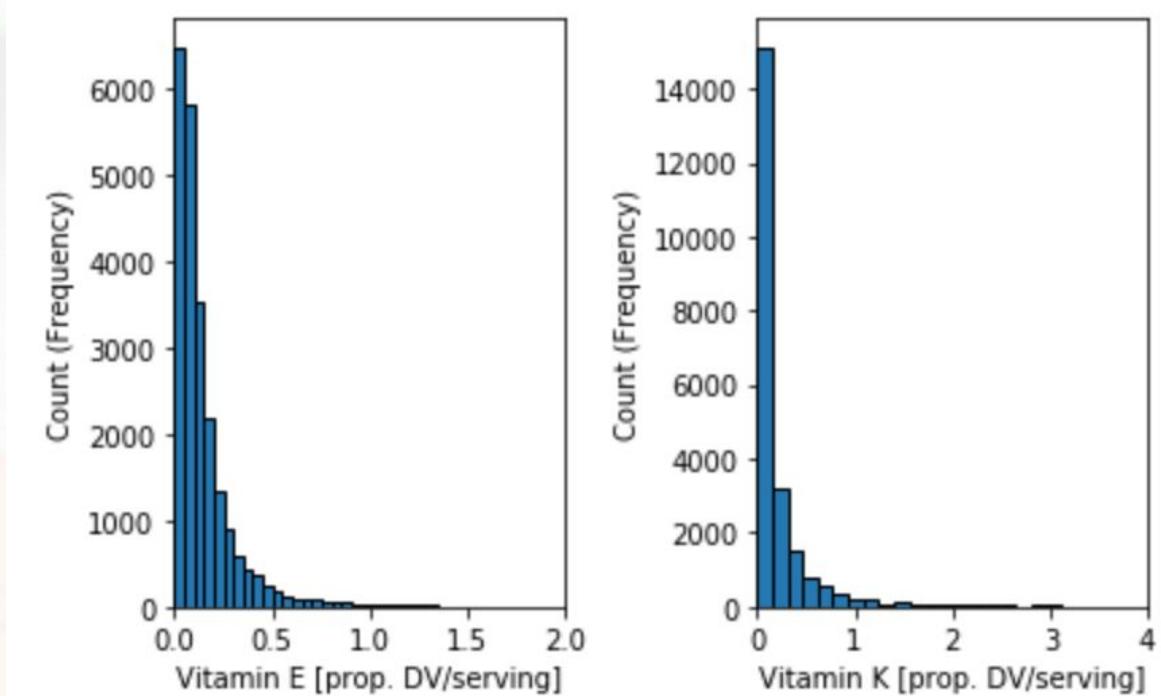


Photo by [amoon ra](#) on [Unsplash](#)

# EDA

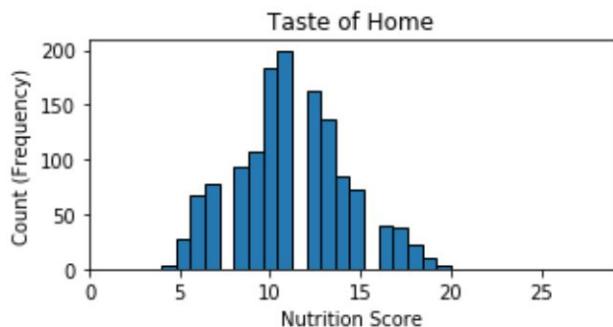
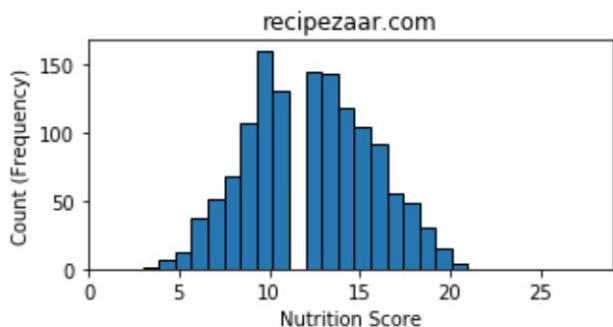
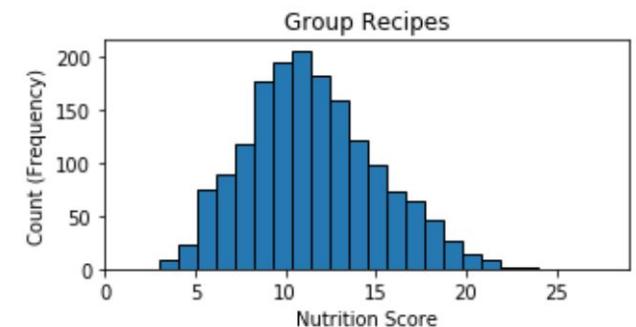
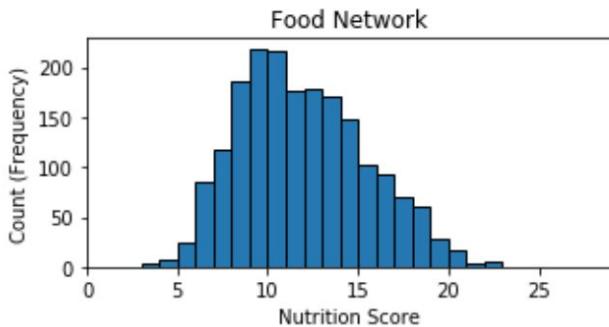
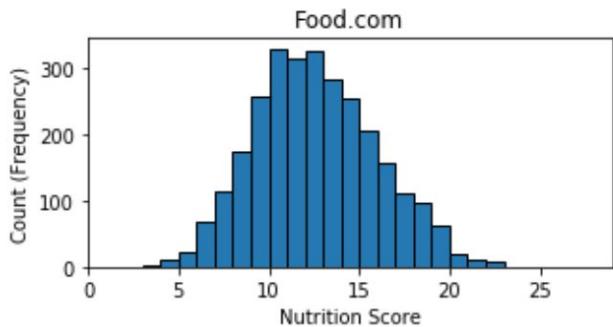
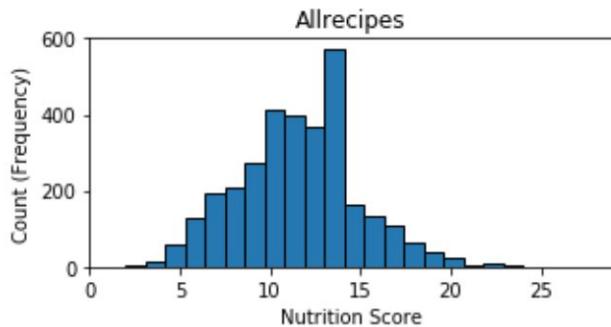
Top 20 sources:

(All Recipes: 3186 recipes-  
dropped when made drop  
dummies)

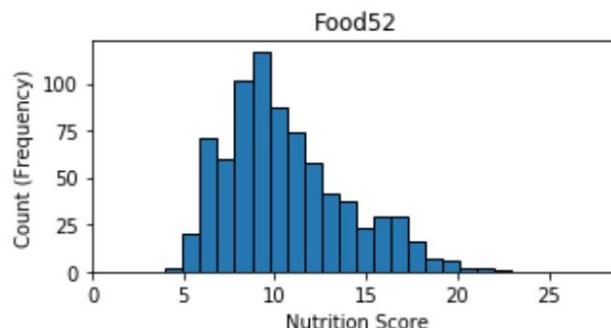
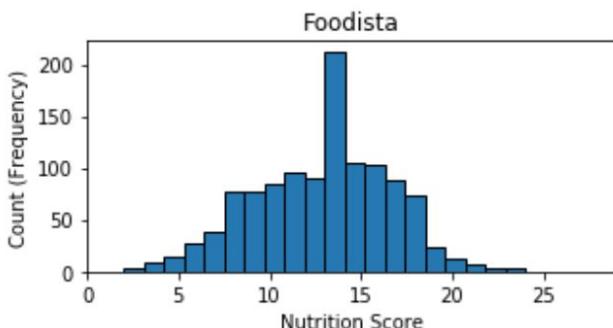
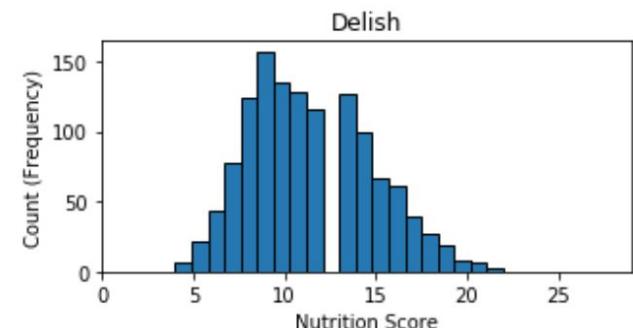
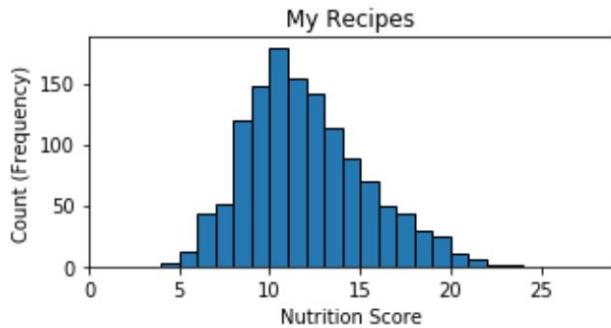
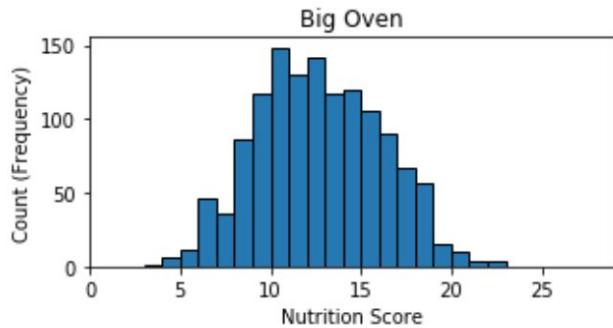
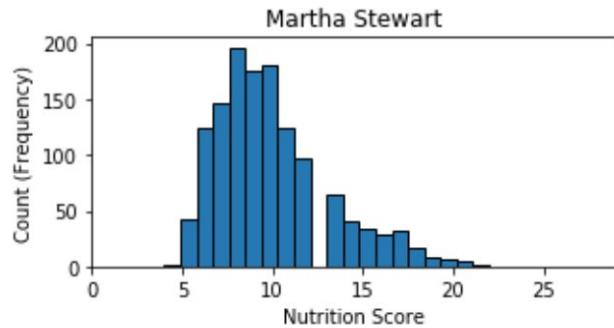
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source_Food Network	1911
source_Group Recipes	1694
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source_Martha Stewart	1324
source_BigOven	1313
source_My Recipes	1291
source_Delish	1268
source_Foodista	1152
source_Food52	786
source_Epicurious	543
source_Williams-Sonoma	511
source_Serious Eats	480
source_Cookstr	447
source_Good Housekeeping	405
source_Kraft Foods	386
source_Saveur	376
source_Kitchen Daily	372

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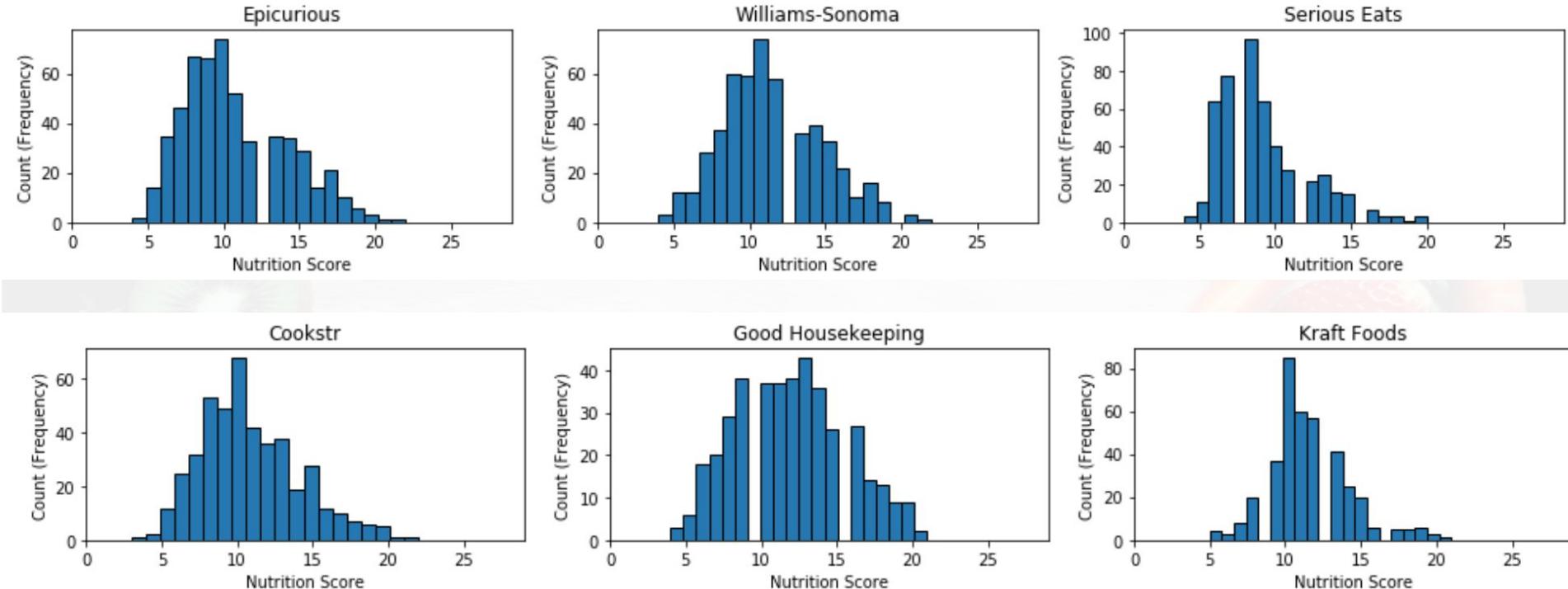
# EDA - Sources of Recipes



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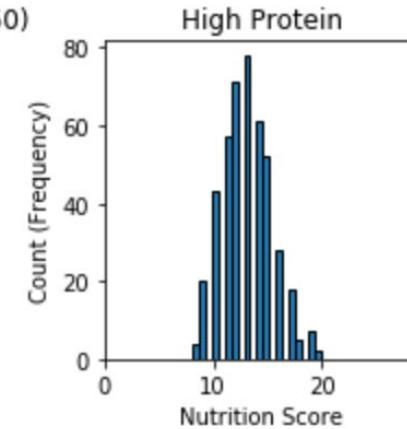
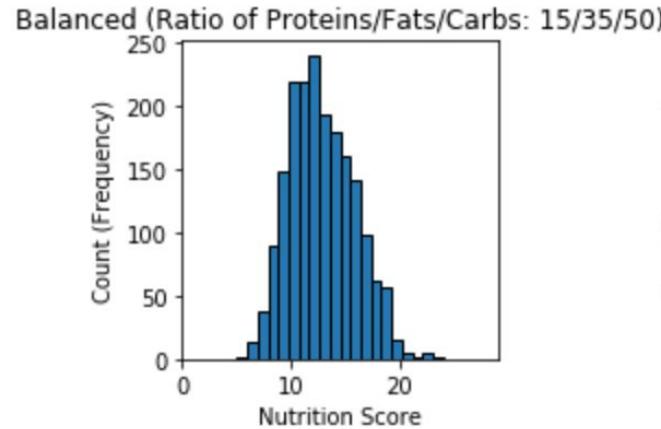
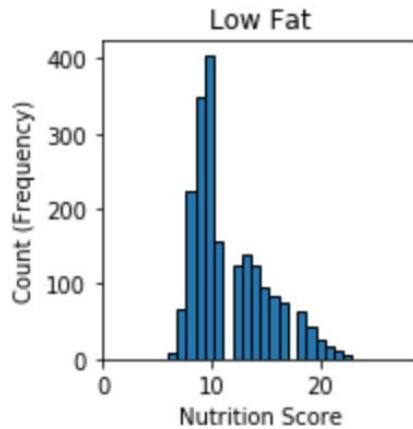
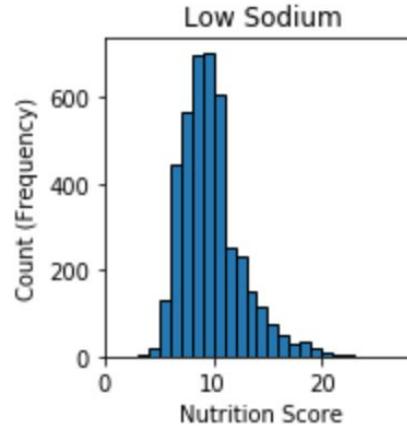
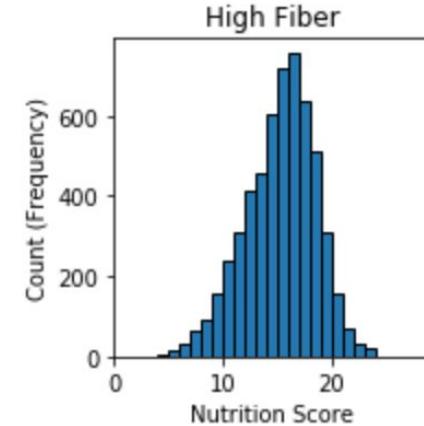
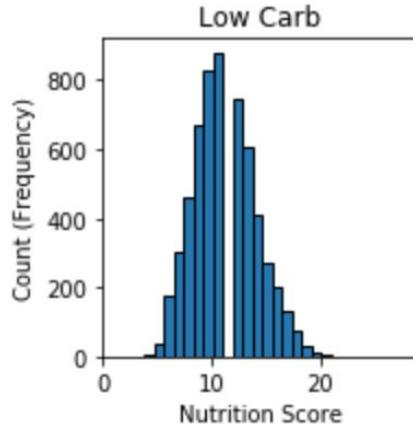
# EDA - Sources of Recipes



# EDA - Diet Labels

diet_labels_Low-Carb	5840
diet_labels_High-Fiber	5582
diet_labels_Low-Sodium	4145
diet_labels_Low-Fat	2010
diet_labels_Balanced	1885
diet_labels_High-Protein	446

# EDA - Diet Labels

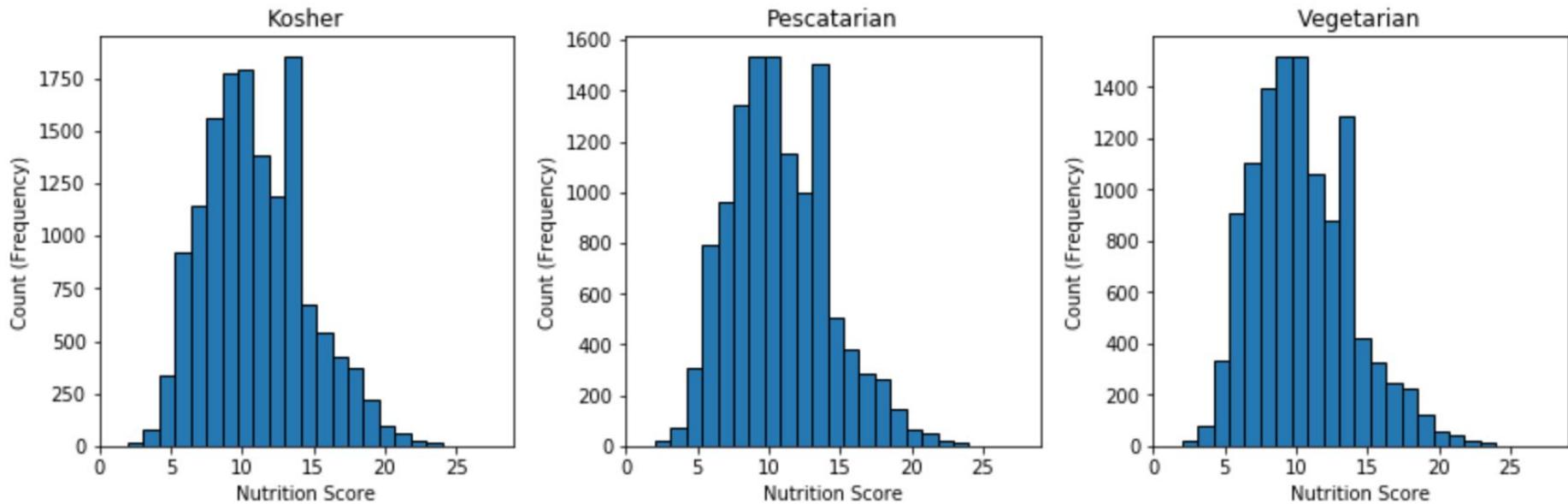


# EDA: Health Labels

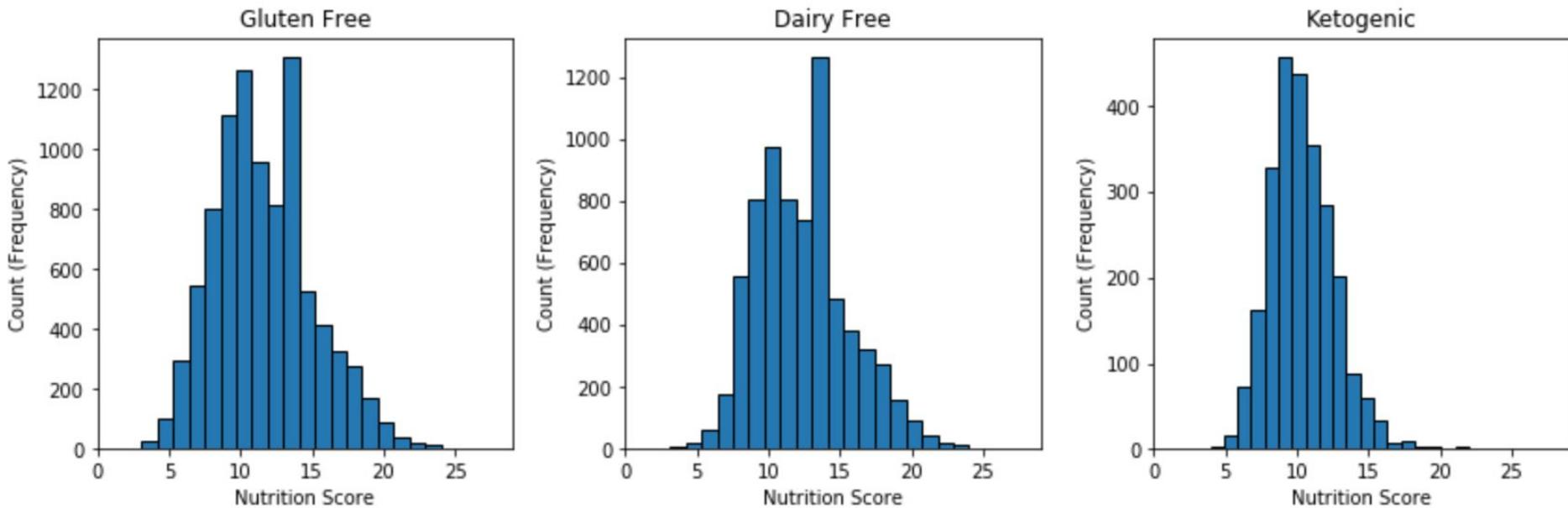
health_labels_Lupine-Free	22938
health_labels_Mollusk-Free	22529
health_labels_Sesame-Free	22459
health_labels_Crustacean-Free	22153
health_labels_Peanut-Free	22124
health_labels_Shellfish-Free	22055
health_labels_Celery-Free	21459
health_labels_Fish-Free	21332
health_labels_Mustard-Free	20949
health_labels_Soy-Free	20901
health_labels_Tree-Nut-Free	20841
health_labels_Alcohol-Free	20436
health_labels_Pork-Free	19289
health_labels_Red-Meat-Free	17280
health_labels_Kosher	14492
health_labels_Egg-Free	14378
health_labels_Pescatarian	11944
health_labels_Vegetarian	11582
health_labels_Wheat-Free	9224
health_labels_Gluten-Free	9112
health_labels_Dairy-Free	7205
health_labels_Sugar-Conscious	6036
health_labels_Kidney-Friendly	4411
health_labels_No oil added	4275
health_labels_Low Potassium	2665
health_labels_Keto-Friendly	2530
health_labels_Vegan	2027
health_labels_Paleo	1023
health_labels_Alcohol-Cocktail	198
health_labels_Low Sugar	25

Photo by [amoon ra](#) on [Unsplash](#)

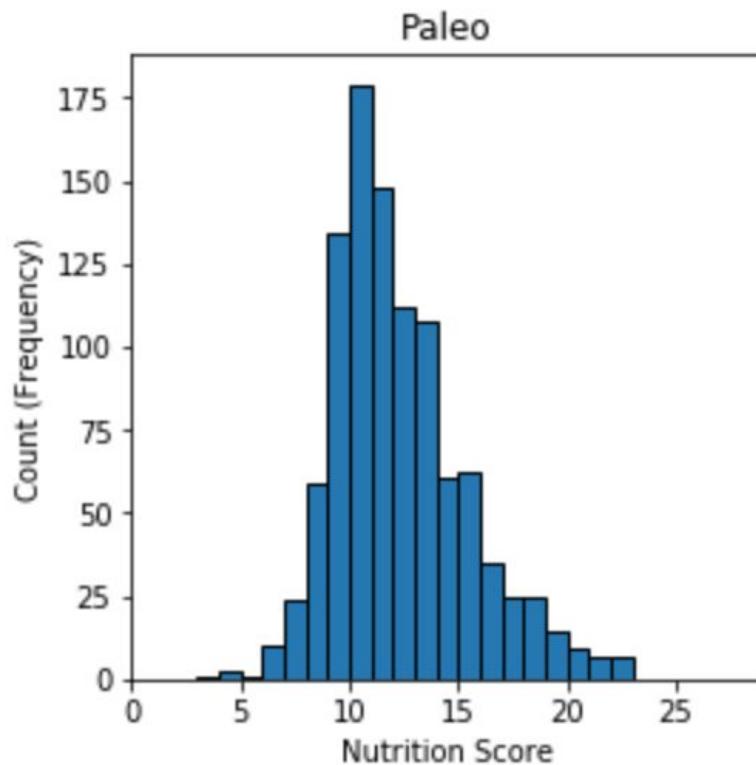
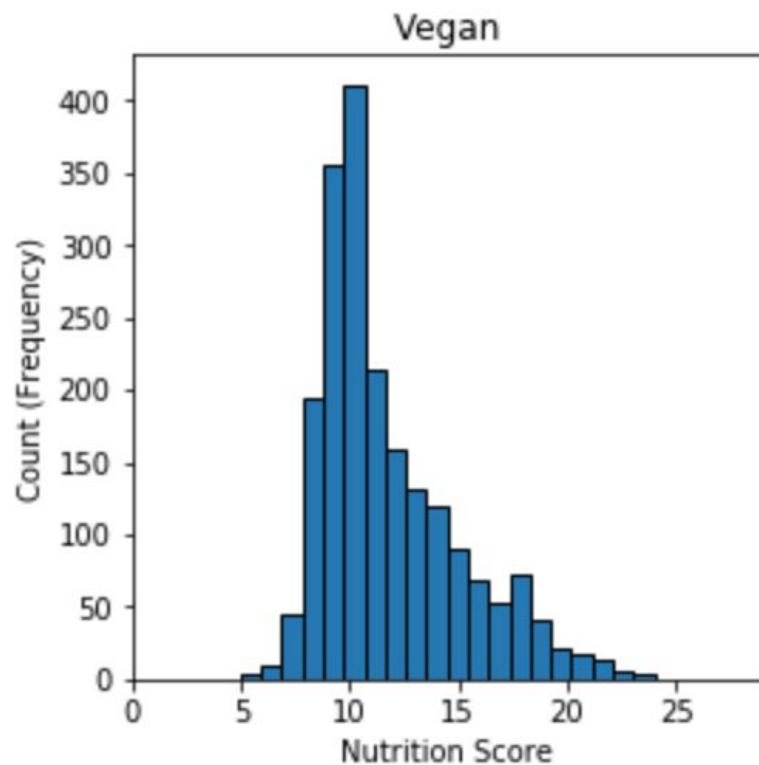
# EDA - Some Diet Types (Using Health Labels)



# EDA - Some Diet Types (Using Health Labels)

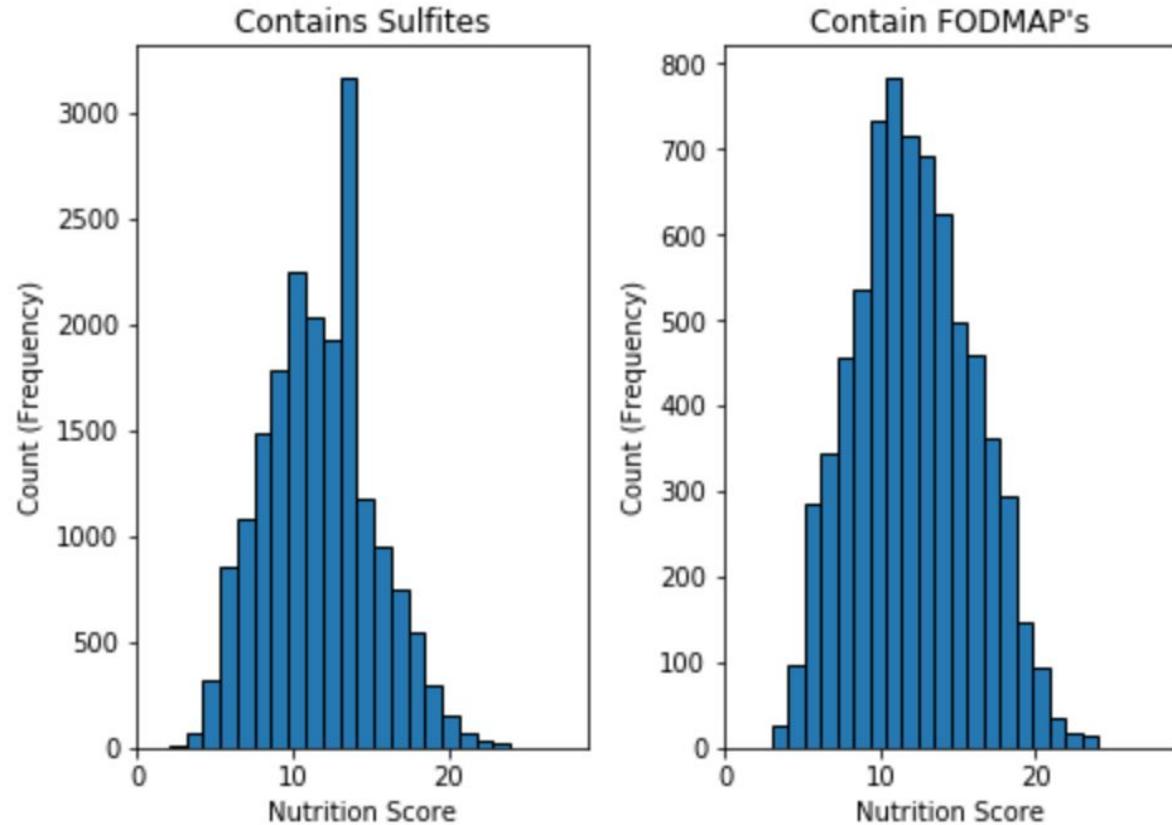


# EDA - Some Diet Types (Using Health Labels)



# EDA: Cautions

cautions_Sulfites	18984
cautions_FODMAP	7210

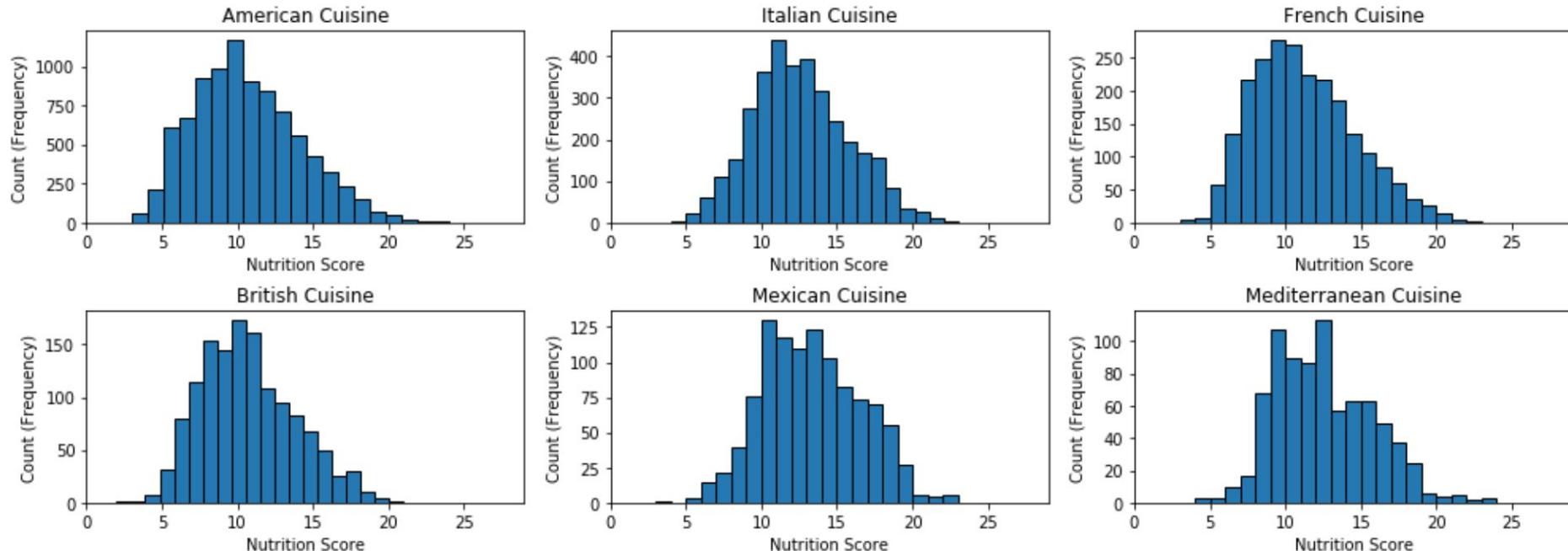


# EDA - Cuisine Types (179 in Dataset)

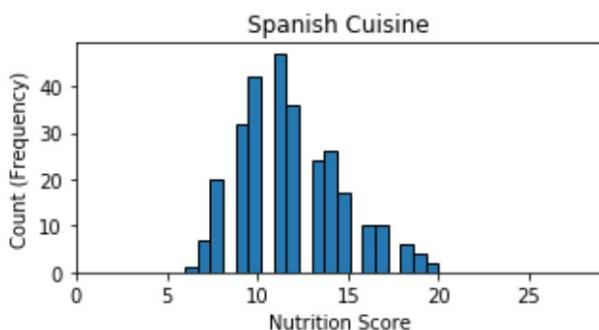
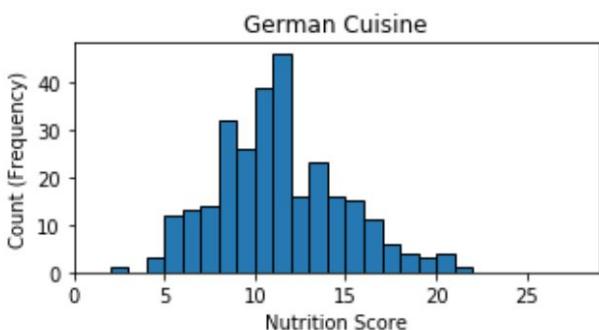
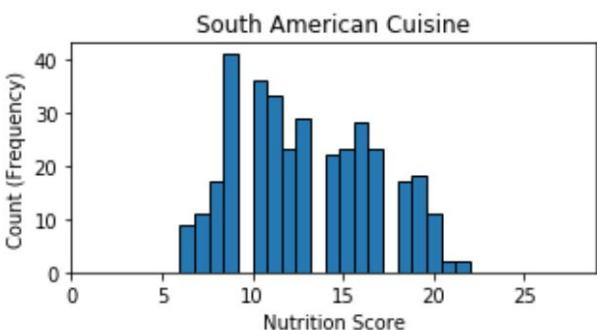
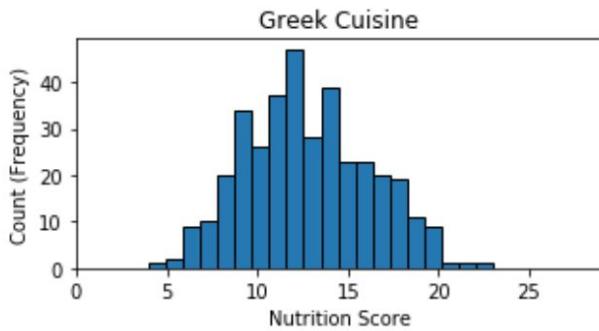
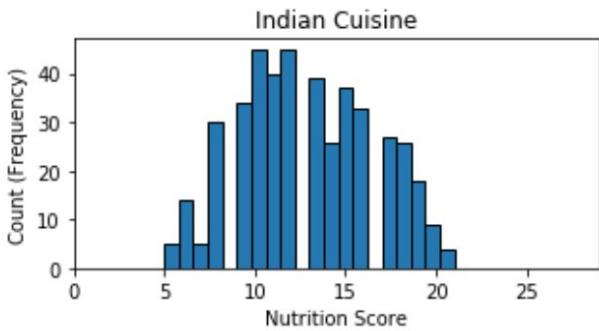
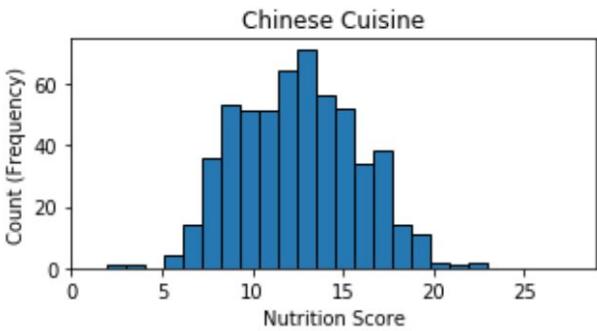
cuisine_type_American	8945
cuisine_type_Italian	3429
cuisine_type_French	2311
cuisine_type_British	1343
cuisine_type_Mexican	1063
cuisine_type_Mediterranean	811
cuisine_type_Chinese	556
cuisine_type_Indian	437
cuisine_type_Greek	361
cuisine_type_South American	345
cuisine_type_German	285
cuisine_type_Spanish	284
cuisine_type_Thai	194
cuisine_type_Japanese	170
cuisine_type_Danish	132
cuisine_type_Eastern Europe	127
cuisine_type_Russian	127
cuisine_type_Arab	125
cuisine_type_Cajun	121
cuisine_type_Caribbean	111
cuisine_type_Brazilian	87
cuisine_type_Moroccan	81
cuisine_type_Malaysian	76
cuisine_type_Indonesian	73
cuisine_type_Turkish	70
cuisine_type_Nordic	69
cuisine_type_African	68
cuisine_type_Uncategorized	64
cuisine_type_Portuguese	60
cuisine_type_Jewish	57

Photo by [amoon ra](#) on [Unsplash](#)

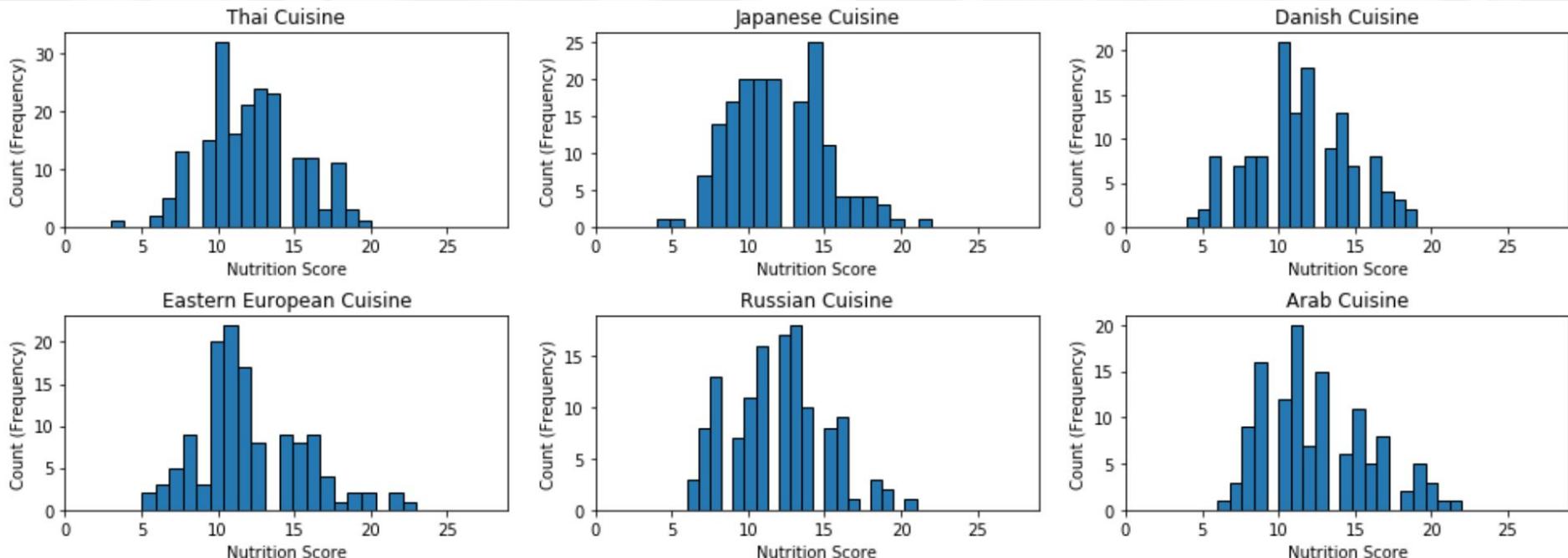
# EDA - Cuisine Types



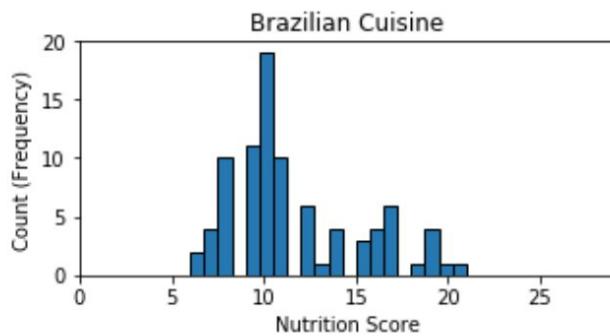
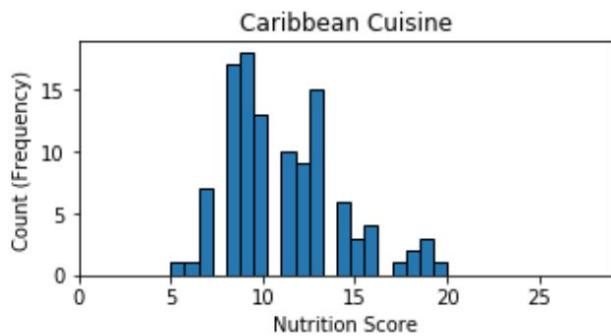
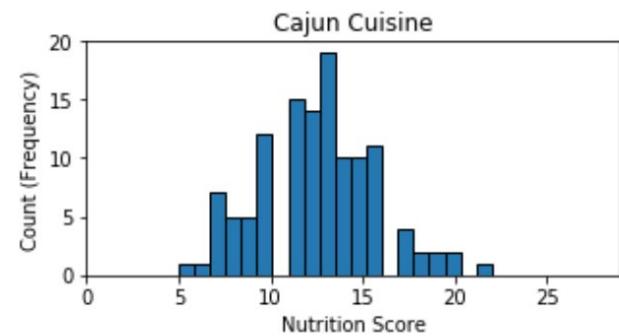
# EDA - Cuisine Types



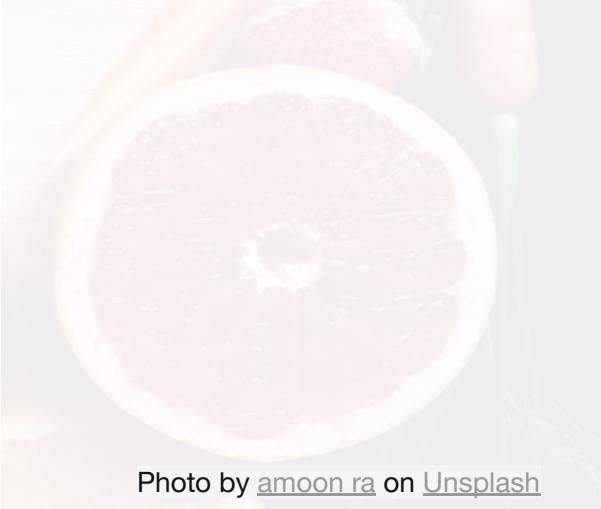
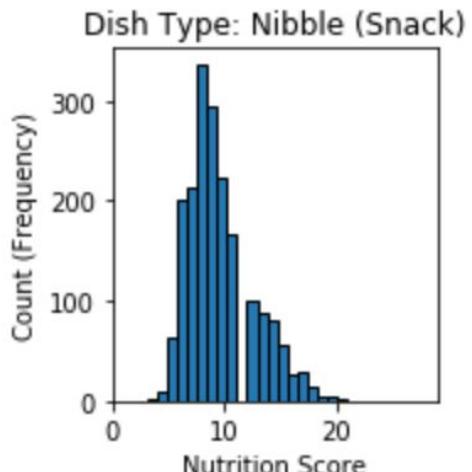
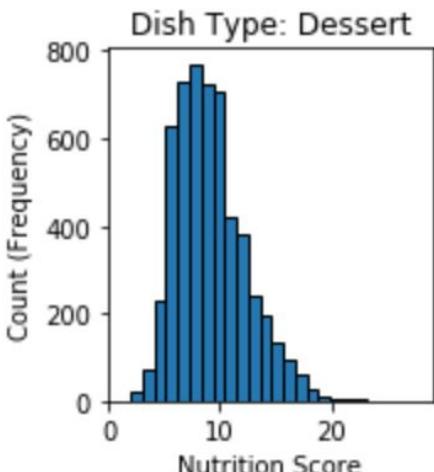
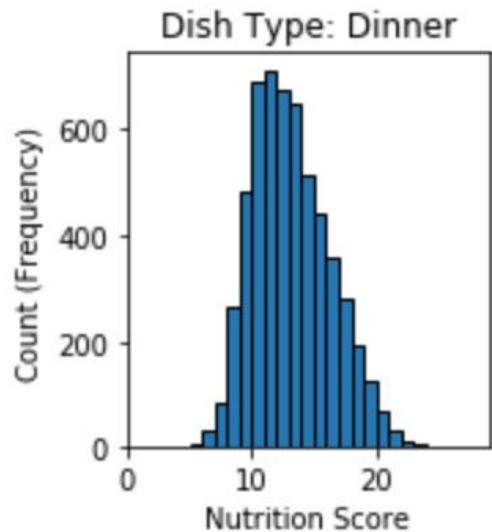
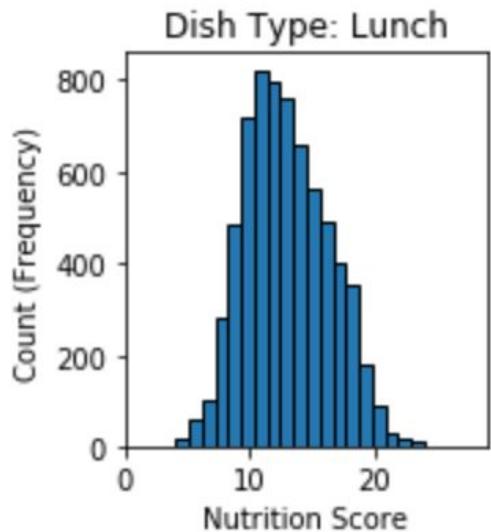
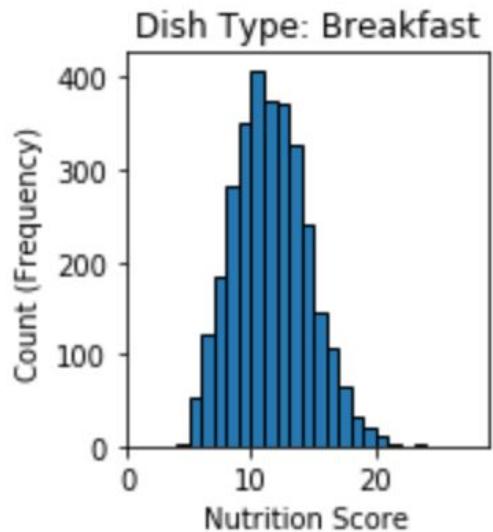
# EDA - Cuisine Types



# EDA - Cuisine Types



# EDA - Dish Types



# EDA - Ingredient Categories (73 to 59 through feature eng.)

ingredient_category_condiments_and_sauces	22493
ingredient_category_vegetables	12958
ingredient_category_dairy	10093
ingredient_category_grains	9229
ingredient_category_oils	8815
ingredient_category_sugars	8414
ingredient_category_eggs	7200
ingredient_category_cheese	6385
ingredient_category_canned_soup	5549
ingredient_category_fruit	5542
ingredient_category_milk	5110
ingredient_category_plant_based_protein	4640
ingredient_category_poultry	3943
ingredient_category_water	3906
ingredient_category_bread, rolls and tortillas	3217
ingredient_category_canned_vegetables	3039
ingredient_category_meats	2998
ingredient_category_cured_meats	2743
ingredient_category_chocolate	1821
ingredient_category_100% juice	1715
ingredient_category_quick_breads_and_pastries	1525
ingredient_category_wines	1366
ingredient_category_sugar_and_syrups	1333
ingredient_category_seafood	1250
ingredient_category_canned_fruit	946
ingredient_category_liquors_and_cocktails	820

ingredient_category_candy	604
ingredient_category_ready-to-eat_cereals	598
ingredient_category_yogurt	566
ingredient_category_100% fruit juice	531
ingredient_category_Vegan_products	476
ingredient_category_crackers	380
ingredient_category_non-dairy_beverages	312
ingredient_category_pastries	298
ingredient_category_coffee_and_tea	275
ingredient_category_canned_seafood	253
ingredient_category_savory_snacks	180
ingredient_category_sweetened_beverages	170
ingredient_category_beer	169
ingredient_category_frozen_treats	166
ingredient_category_sugar_jam	119
ingredient_category_flavored_water	56
ingredient_category_canned_grains	54
ingredient_category_salads	34
ingredient_category_mixed_grains	18
ingredient_category_protein_and_nutritional_powders	18
ingredient_category_canned_meats	14
ingredient_category_mixed_soup	12
ingredient_category_frozen_grained_based	12
ingredient_category_pizza	6
ingredient_category_cooked_grains	6
ingredient_category_sandwiches	5
ingredient_category_frozen_poultry	5
ingredient_category_frozen_grains	4
ingredient_category_dried_fruit_and_nuts	3
ingredient_category_Baby_food	2
ingredient_category_mixed_seafood	1
ingredient_category_Mexican	1
ingredient_category_canned_poultry	1

# EDA - Distribution of Nutrition Scores for Dataset

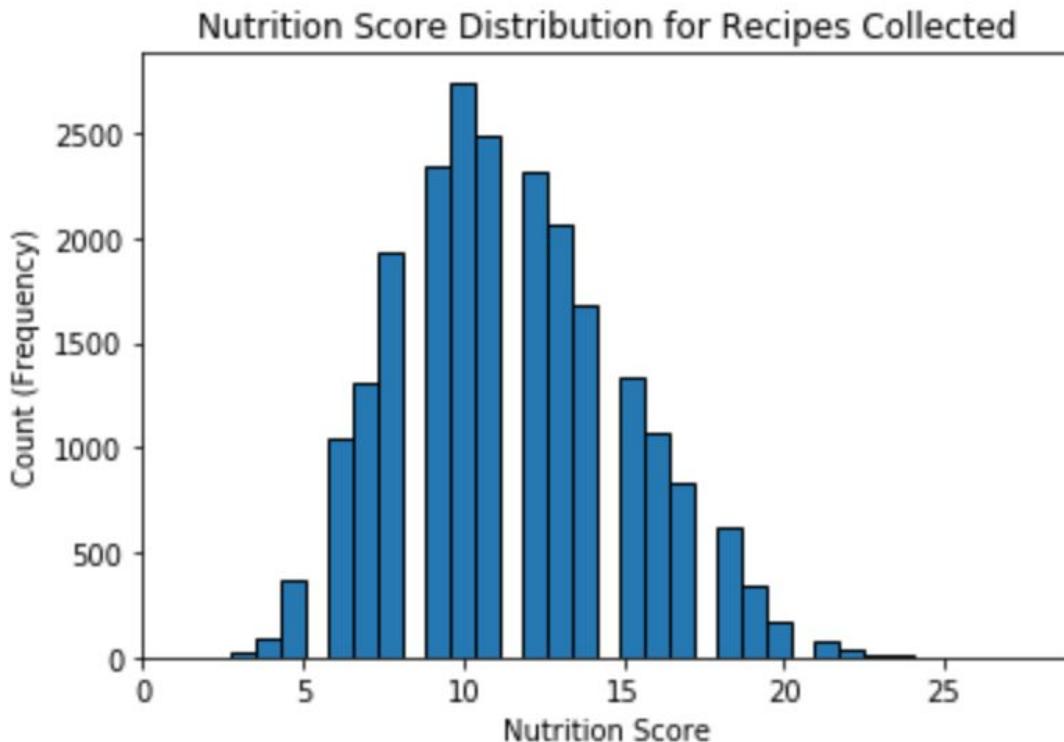


Photo by [amoon ra](#) on [Unsplash](#)

# Model Building

- Removed object type data
- Scaled data using standard scalar
- Used scipy's sparse matrix package to change data to sparse matrix
- Used sklearn's metrics.pairwise.cosine\_similarity module to generate recommender

$$\text{Cosine similarity} = \frac{\underline{\mathbf{X}} * \underline{\mathbf{Y}}}{\|\mathbf{X}\| \|\mathbf{Y}\|}$$

- Added bias - sorted top 100 recommendations by nutrition score and output top 10 highest nutrition scores

# Model Evaluation - The Recipe I Crave

Say, Belgian waffles sound delicious right now. Here's a recipe for some Brussels waffles I like, but maybe we should find another recipe (nutrient/health score only 7)



**Yield: Makes 8**

## Ingredients

- 1  $\frac{3}{4}$  cups self-rising flour, preferably Aunt Jemima brand
- 1 tsp. granulated sugar
- 4 eggs, separated
- 1  $\frac{1}{4}$  cups water
- $\frac{1}{2}$  tsp. vanilla extract
- 16 tbsp. (2 sticks) unsalted butter, melted
- 4-6 cups whipped cream
- 2 pints ripe, in-season strawberries, hulled and halved
- Confectioners' sugar

Oh dear!  
That's a lot  
of butter and  
cream!

# Model Evaluation - Unbiased Recommendations

Say, Belgian waffles sound delicious right now. Here's a recipe for some Brussels waffles I like, but maybe we should find another recipe (nutrient/health score only 7)

```
url = 'http://www.saveur.com/article/Recipes/Belgian-Waffles'  
recommender_health_bias(url)
```

```
Top 10 results before adding the health bias: url  
http://www.saveur.com/article/Recipes/Belgian-Waffles 1.000000  
http://www.saveur.com/article/Recipes/Buttermilk-Waffles 0.961426  
https://www.allrecipes.com/recipe/17681/belgian-waffles/ 0.942383  
http://allrecipes.com/Recipe/Waffle-Cookies-I/Detail.aspx 0.939453  
http://www.food.com/recipe/classic-belgian-waffle-490894 0.937988  
http://www.food.com/recipe/the-best-belgian-waffles-63071 0.927734  
https://food52.com/recipes/8231-raised-waffles 0.925781  
https://www.foodnetwork.com/recipes/waffle-of-insane-greatness-recipe-1943589 0.924316  
http://www.recipezaar.com/Overnight-Waffles-16235 0.923828  
http://www.foodista.com/recipe/6SWXKT4W/raised-waffles 0.920410  
Name: http://www.saveur.com/article/Recipes/Belgian-Waffles, dtype: float16
```

# Model Evaluation - Biased Recommendation

The health score doubled! Now 14 points!

Top 10 results after adding the health bias: url

		nutrition_score
<a href="http://www.williams-sonoma.com/recipe/old-fashioned-buttermilk-waffles.html">http://www.williams-sonoma.com/recipe/old-fashioned-buttermilk-waffles.html</a>	0.827148	14
<a href="http://www.goodhousekeeping.com/food-recipes/a7848/belgian-waffles-3910/">http://www.goodhousekeeping.com/food-recipes/a7848/belgian-waffles-3910/</a>	0.899414	13
<a href="http://www.recipezaar.com/Overnight-Waffles-16235">http://www.recipezaar.com/Overnight-Waffles-16235</a>	0.923828	13
<a href="http://www.saveur.com/article/Recipes/Breakfast-Bread">http://www.saveur.com/article/Recipes/Breakfast-Bread</a>	0.252441	13
<a href="http://www.cookstr.com/recipes/sourdough-waffles">http://www.cookstr.com/recipes/sourdough-waffles</a>	0.886230	13
<a href="http://www.grouprecipes.com/126604/buttermilk-waffles.html">http://www.grouprecipes.com/126604/buttermilk-waffles.html</a>	0.919434	13
<a href="https://www.allrecipes.com/recipe/17681/belgian-waffles/">https://www.allrecipes.com/recipe/17681/belgian-waffles/</a>	0.942383	12
<a href="http://www.foodista.com/recipe/2437QZKM/waffle-or-pancake-mix">http://www.foodista.com/recipe/2437QZKM/waffle-or-pancake-mix</a>	0.839844	12
<a href="http://www.marthastewart.com/343477/yogurt-waffles">http://www.marthastewart.com/343477/yogurt-waffles</a>	0.884766	12
<a href="http://www.food.com/recipe/basic-batter-waffles-110683">http://www.food.com/recipe/basic-batter-waffles-110683</a>	0.919922	12

Name: <http://www.saveur.com/article/Recipes/Belgian-Waffles>, dtype: float16

# Model Evaluation - Top Biased Recommendation



## Ingredients:

2 cups (10 oz./315 g) all-purpose flour  
2 Tbs. malted milk powder or granulated sugar  
1 Tbs. baking powder  
1 tsp. baking soda  
1/4 tsp. fine sea salt  
2 1/4 cups (18 fl. oz./560 ml) buttermilk  
3 Tbs. unsalted butter, melted, plus room temperature butter for serving  
3 eggs, separated, at room temperature  
1 tsp. vanilla extract  
Canola oil for cooking, if needed  
Maple syrup for serving

Recipe adapted from Williams-Sonoma *Breakfast Comforts*, by Rick Rodgers (Weldon Owen, 2010)  
<https://www.williams-sonoma.com/recipe/old-fashioned-buttermilk-waffles.html>

Photo by [amoon ra](#) on [Unsplash](#)

# Model Evaluation - The Recipe I Crave

Now I'm in the mood for Mexican food, but the recipe I found only has a health score of 8.



## Ingredients

4 to 8 soft corn tortillas,  
warmed in the microwave or  
in a foil-wrapped pouch in the  
oven or toaster oven

1 1/2 ounces picked roast  
turkey meat per tortilla

3 tablespoons vegetable or  
canola oil

Kosher salt

1/4 cup **homemade** or store-  
bought *mole poblano* per  
tortilla (see note)

1 tablespoon Mexican-style  
crema per tortilla (see note)

Crumbled cotija cheese for  
serving

Sliced white onions for  
serving

Chopped fresh cilantro leaves  
for serving

Lime wedges, for serving

# Model Evaluation - Unbiased Recommendations

```
url = 'http://www.serious eats.com/recipes/2014/11/15-minute-turkey-mole-enchilada-recipe.html'  
recommender_health_bias(url)
```

```
Top 10 results before adding the health bias: url  
http://www.serious eats.com/recipes/2014/11/15-minute-turkey-mole-enchilada-recipe.html 1.000000  
http://www.serious eats.com/recipes/2012/01/how-to-make-cupcakes-in-an-ice-cream-cone-recipe.html 0.693848  
http://www.serious eats.com/recipes/2010/01/pulled-pork-nachos-super-bowl-recipe.html 0.689941  
http://www.serious eats.com/recipes/2012/05/gluten-free-flour-tortillas.html 0.665527  
http://www.serious eats.com/recipes/2010/06/jim-laheys-no-knead-pizza-dough-recipe.html 0.617188  
http://www.serious eats.com/recipes/2012/03/chess-pie-recipe.html 0.614746  
http://www.serious eats.com/recipes/2014/12/the-best-chicken-enchiladas-recipe.html 0.608398  
http://www.serious eats.com/recipes/2012/03/sweet-potato-pie-recipe.html 0.608398  
http://www.serious eats.com/recipes/2012/05/hoosier-sugar-cream-pie-recipe.html 0.595703  
http://www.serious eats.com/recipes/2014/12/classic-american-buttercream-recipe.html 0.586914  
Name: http://www.serious eats.com/recipes/2014/11/15-minute-turkey-mole-enchilada-recipe.html, dtype: float16
```

# Model Evaluation - Biased Recommendations

Top 10 results after adding the health bias: url

url	nutrition_score
<a href="http://www.seriouseats.com/recipes/2010/12/enchiladas-suizas-rick-bayless-recipe.html">http://www.seriouseats.com/recipes/2010/12/enchiladas-suizas-rick-bayless-recipe.html</a>	0.555176
<a href="http://www.seriouseats.com/recipes/2014/12/the-best-chicken-enchiladas-recipe.html">http://www.seriouseats.com/recipes/2014/12/the-best-chicken-enchiladas-recipe.html</a>	0.608398
<a href="http://www.seriouseats.com/recipes/2010/06/jim-laheys-no-knead-pizza-dough-recipe.html">http://www.seriouseats.com/recipes/2010/06/jim-laheys-no-knead-pizza-dough-recipe.html</a>	0.617188
<a href="http://www.seriouseats.com/recipes/2011/04/black-eyed-peas-with-ham-hock-recipe.html">http://www.seriouseats.com/recipes/2011/04/black-eyed-peas-with-ham-hock-recipe.html</a>	0.489990
<a href="http://www.seriouseats.com/recipes/2014/10/white-chili-with-chicken-best.html">http://www.seriouseats.com/recipes/2014/10/white-chili-with-chicken-best.html</a>	0.468018
<a href="http://www.seriouseats.com/recipes/2012/01/cornish-pasty-british-meat-hand-pie-recipe.html">http://www.seriouseats.com/recipes/2012/01/cornish-pasty-british-meat-hand-pie-recipe.html</a>	0.479492
<a href="http://www.seriouseats.com/recipes/2011/07/spinach-baked-eggs-breakfast-brunch-recipe.html">http://www.seriouseats.com/recipes/2011/07/spinach-baked-eggs-breakfast-brunch-recipe.html</a>	0.475342
<a href="http://www.seriouseats.com/recipes/2011/08/how-to-make-croissants-french-pastry-recipe.html">http://www.seriouseats.com/recipes/2011/08/how-to-make-croissants-french-pastry-recipe.html</a>	0.520996
<a href="http://www.seriouseats.com/recipes/2013/03/chicken-and-leek-pie-recipe.html">http://www.seriouseats.com/recipes/2013/03/chicken-and-leek-pie-recipe.html</a>	0.510742
<a href="http://www.seriouseats.com/recipes/2012/06/pizza-bread-recipe.html">http://www.seriouseats.com/recipes/2012/06/pizza-bread-recipe.html</a>	0.507812

Name: <http://www.seriouseats.com/recipes/2014/11/15-minute-turkey-mole-enchilada-recipe.html>, dtype: float64



# Model Evaluation - Top Biased Recommendation



Kindelsperger, Nick.

<https://www.serouseats.com/recipes/2010/12/enchiladas-suizas-rick-bayless-recipe.html>

## Ingredients

1 pound tomatillos, husks removed and rinsed

1 medium white onion, sliced  $\frac{1}{4}$ -inch thick

3 garlic cloves

3 serranos, stemmed

3  $\frac{1}{2}$  tablespoons canola oil, divided

2 cups vegetable or chicken broth

$\frac{1}{2}$  cup Mexican crema (or creme fraiche)

2 large carrots, peeled and cut into  $\frac{1}{2}$ -inch cubes

1 large red onion, peeled and cut into  $\frac{1}{2}$ -inch cubes

2 cups cremini mushrooms, cleaned, stems removed, and cut into  $\frac{1}{2}$ -inch cubes

1 butternut squash, peeled and seeds scooped out, flesh cut into  $\frac{1}{2}$ -inch cubes

12 corn tortillas

$\frac{2}{3}$  cup chihuahua cheese (or other Mexican melting cheese)

### For Garnish

$\frac{1}{4}$  White onion, thinly sliced

4 tablespoons cilantro, chopped

Photo by [amoon ra](#) on [Unsplash](#)

# Model Evaluation - The Recipe I Crave

I am craving queso, but the health score is only 12.



## Ingredients:

12 fresh poblano chiles

4 tablespoons salted butter

4 onions, diced

4 jalapenos, minced

2 cloves garlic, grated

4 cups milk

4 cups heavy cream

1 tablespoon chili powder

Kosher salt and freshly ground black pepper

Kosher salt and freshly ground black pepper

4 pounds queso blanco-style processed cheese, such as Velveeta Queso Blanco, cut into large cubes

8 cups grated sharp Cheddar

8 cups grated Monterey Jack cheese

Four 14.5-ounce cans petite-diced tomatoes

Drummond, Ree.

<https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134>

# Model Evaluation - Unbiased Recommendations

```
url = 'https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134'  
recommender_health_bias(url)
```

Top 10 results before adding the health bias: url

<a href="https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134">https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134</a>	1.000000
<a href="https://www.foodnetwork.com/recipes/jamie-deen/pimento-cheese-dip-recipe-2108638">https://www.foodnetwork.com/recipes/jamie-deen/pimento-cheese-dip-recipe-2108638</a>	0.667969
<a href="https://www.allrecipes.com/recipe/45582/green-chili-casserole/">https://www.allrecipes.com/recipe/45582/green-chili-casserole/</a>	0.665527
<a href="http://www.food.com/recipe/queso-blanco-321492">http://www.food.com/recipe/queso-blanco-321492</a>	0.657715
<a href="https://www.allrecipes.com/recipe/255525/queso-blanco/">https://www.allrecipes.com/recipe/255525/queso-blanco/</a>	0.644531
<a href="http://www.myrecipes.com/recipe/spicy-stuffed-peppers">http://www.myrecipes.com/recipe/spicy-stuffed-peppers</a>	0.632812
<a href="http://www.food.com/recipe/grilled-tomato-cheese-sandwiches-403444">http://www.food.com/recipe/grilled-tomato-cheese-sandwiches-403444</a>	0.607910
<a href="https://www.foodnetwork.com/recipes/food-network-kitchen/peppermint-hot-cocoa-3362135">https://www.foodnetwork.com/recipes/food-network-kitchen/peppermint-hot-cocoa-3362135</a>	0.607422
<a href="http://www.tasteofhome.com/Recipes/Cheesy-Chili-Casserole">http://www.tasteofhome.com/Recipes/Cheesy-Chili-Casserole</a>	0.606445
<a href="https://www.foodnetwork.com/recipes/food-network-kitchen/vegetarian-enchiladas-3364279">https://www.foodnetwork.com/recipes/food-network-kitchen/vegetarian-enchiladas-3364279</a>	0.604004

Name: <https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134>, dtype: float16

# Model Evaluation - Biased Recommendations

Top 10 results after adding the health bias: url

url	nutrition_score
<a href="https://www.allrecipes.com/recipe/230498/grandmas-chicken-and-black-bean-chili/">https://www.allrecipes.com/recipe/230498/grandmas-chicken-and-black-bean-chili/</a>	0.496582
<a href="http://www.food.com/recipe/turkey-black-bean-chili-56201">http://www.food.com/recipe/turkey-black-bean-chili-56201</a>	0.515137
<a href="https://www.foodnetwork.com/recipes/valerie-bertinelli/three-bean-turkey-chili-3482841">https://www.foodnetwork.com/recipes/valerie-bertinelli/three-bean-turkey-chili-3482841</a>	0.516113
<a href="http://www.food.com/recipe/black-bean-sweet-potato-enchiladas-390176">http://www.food.com/recipe/black-bean-sweet-potato-enchiladas-390176</a>	0.503418
<a href="https://www.allrecipes.com/recipe/217002/quinoa-and-black-bean-chili/">https://www.allrecipes.com/recipe/217002/quinoa-and-black-bean-chili/</a>	0.503418
<a href="https://www.foodnetwork.com/recipes/ree-drummond/chili-beans-2632850">https://www.foodnetwork.com/recipes/ree-drummond/chili-beans-2632850</a>	0.495605
<a href="http://www.food.com/recipe/three-bean-chili-101581">http://www.food.com/recipe/three-bean-chili-101581</a>	0.477539
<a href="https://www.allrecipes.com/recipe/235049/cheesy-slow-cooker-white-chili/">https://www.allrecipes.com/recipe/235049/cheesy-slow-cooker-white-chili/</a>	0.568848
<a href="https://www.foodnetwork.com/recipes/food-network-kitchen/vegetarian-enchiladas-3364279">https://www.foodnetwork.com/recipes/food-network-kitchen/vegetarian-enchiladas-3364279</a>	0.604004
<a href="https://www.foodnetwork.com/recipes/sandra-lee/no-bean-beef-chili-recipe-2014720">https://www.foodnetwork.com/recipes/sandra-lee/no-bean-beef-chili-recipe-2014720</a>	0.509766

Name: <https://www.foodnetwork.com/recipes/ree-drummond/queso-blanco-3064134>, dtype: float16



# Model Evaluation - Top Biased Recommendation



## Ingredients

- |   |   |
|---|---|
| 2 tablespoons olive oil   | 2 (5 ounce) cans chicken, drained           |
| 1 large onion, chopped  | 2 (1.25 ounce) packages chili seasoning mix |
| <p><b>White Onion, Large</b><br/>See Store for Price<br/><a href="#">Buy on AmazonFresh</a></p>  | 1 teaspoon ground cumin                     |
| 3 (15 ounce) cans black beans, rinsed and drained   | salt and ground black pepper to taste       |
| 2 (14.5 ounce) cans diced tomatoes  | Add all ingredients to list                 |

Kmpelham. <https://www.allrecipes.com/recipe/230498/grandmas-chicken-and-black-bean-chili/>

# Model Evaluation - The Recipe I Crave

Nutrition score: 4



Oleson Moore, Jessie.

<https://www.seriouseats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html>

## Ingredients

### For the Cake:

- 2 1/2 cups (about 12 1/2 ounces) flour
- 2 teaspoons baking soda
- 1 teaspoon baking powder
- 1/2 teaspoon salt
- 3/4 cup hot water
- 1/2 cup (about 1 1/2 ounces) Dutch-processed cocoa powder (Hershey's Special Dark also works)
- 1 cup (2 sticks) unsalted butter, softened
- 2 cups (about 14 ounces) granulated sugar
- 2 large eggs

1 cup (about 8 ounces) buttermilk, at room temperature

2 teaspoons vanilla extract

### For the Frosting:

- 1 1/2 cups (about 11 1/4 ounces) packed light brown sugar
- 1 cup (about 8 ounces) evaporated milk
- 1/2 cup (1 stick) unsalted butter, softened and cut into 1/2 inch pieces
- 1/2 teaspoon salt
- 8 ounces bittersweet chocolate, coarsely chopped
- 1 teaspoon vanilla extract
- 3 cups (about 12 ounces) confectioners' sugar, sifted

Photo by [amoon ra](#) on [Unsplash](#)

# Model Evaluation - Unbiased Recommendations

```
url = 'http://www.seriouseats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html'  
recommender_health_bias(url)
```

Top 10 results before adding the health bias: url

http://www.seriouseats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html	1.000000
http://www.seriouseats.com/recipes/2012/09/double-chocolate-whoopie-pie-recipes.html	0.889160
http://www.seriouseats.com/recipes/2013/02/lee-bros-caramel-cake-recipe.html	0.854004
http://www.seriouseats.com/recipes/2012/05/classic-boston-cream-pie-recipe.html	0.854004
http://www.seriouseats.com/recipes/2012/01/let-them-eat-chocolate-chip-cookie-cake-recipe.html	0.848145
http://www.seriouseats.com/recipes/2013/01/chocolate-cream-pie-recipe.html	0.824707
http://www.seriouseats.com/recipes/2012/01/chocolate-cake-doughnuts--make-at-home-recipe.html	0.822754
http://www.seriouseats.com/recipes/2011/11/chocolate-chip-cookie-pie-recipe.html	0.818359
http://www.seriouseats.com/recipes/2012/04/marlow-and-sons-salted-chocolate-caramel-tart-recipe.html	0.812500
http://www.seriouseats.com/recipes/2013/09/smores-cake-marshmallow-layer-cake-recipe.html	0.806641

Name: http://www.seriouseats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html, dtype: float16

# Model Evaluation - Biased Recommendations

		nutrition_score
Top 10 results after adding the health bias: url		13
<a href="http://www.serious eats.com/recipes/2012/11/pumpkin-cornbread-recipe.html">http://www.serious eats.com/recipes/2012/11/pumpkin-cornbread-recipe.html</a>	0.6962	
89		13
<a href="http://www.serious eats.com/recipes/2013/02/peanut-butter-banana-layer-cake-recipe.html">http://www.serious eats.com/recipes/2013/02/peanut-butter-banana-layer-cake-recipe.html</a>	0.7568	
36		12
<a href="http://www.serious eats.com/recipes/2009/11/sunday-brunch-ricotta-pancakes-recipe-breakfast.html">http://www.serious eats.com/recipes/2009/11/sunday-brunch-ricotta-pancakes-recipe-breakfast.html</a>	0.7148	
44		12
<a href="http://www.serious eats.com/recipes/2013/04/bread-and-butter-pudding-recipe.html">http://www.serious eats.com/recipes/2013/04/bread-and-butter-pudding-recipe.html</a>	0.6752	
93		12
<a href="http://www.serious eats.com/recipes/2011/08/chocolate-bread-david-lebovitz-recipe.html">http://www.serious eats.com/recipes/2011/08/chocolate-bread-david-lebovitz-recipe.html</a>	0.6679	
69		12
<a href="http://www.serious eats.com/recipes/2012/01/chocolate-souffle-cake-how-to-make-technique-recipe.html">http://www.serious eats.com/recipes/2012/01/chocolate-souffle-cake-how-to-make-technique-recipe.html</a>	0.7958	
98		12
<a href="http://www.serious eats.com/recipes/2014/02/chocolate-pot-du-creme.html">http://www.serious eats.com/recipes/2014/02/chocolate-pot-du-creme.html</a>	0.7573	
24		12
<a href="http://www.serious eats.com/recipes/2013/06/red-white-and-blueberry-shortcake-recipe.html">http://www.serious eats.com/recipes/2013/06/red-white-and-blueberry-shortcake-recipe.html</a>	0.6411	
13		12
<a href="http://www.serious eats.com/recipes/2012/11/epicurious-irish-soda-bread-with-raisins-and-caraway-recipe.html">http://www.serious eats.com/recipes/2012/11/epicurious-irish-soda-bread-with-raisins-and-caraway-recipe.html</a>	0.7363	
28		11
<a href="http://www.serious eats.com/recipes/2011/10/apple-pie-with-cheddar-crust-recipe.html">http://www.serious eats.com/recipes/2011/10/apple-pie-with-cheddar-crust-recipe.html</a>	0.6455	
08		11
Name: <a href="http://www.serious eats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html">http://www.serious eats.com/recipes/2012/07/wellesley-fudge-cake-recipe.html</a> , dtype: float16		

# Model Evaluation - 6th Biased Recommendation



Weisenthal, Lauren.

<https://www.serouseats.com/recipes/2012/01/chocolate-souffle-cake-how-to-make-technique-recipe.html>

## Ingredients

Approximately 3 tablespoons of softened butter, for greasing

Approximately 3 tablespoons granulated sugar, for coating ramekins

1.2 ounces heavy cream

1.2 ounces milk

1.75 ounces 71% chocolate, chopped

1.75 ounces unsweetened chocolate, chopped

1.7 ounces cocoa powder

3.5 ounces water

8.9 ounces egg whites (from approximately 8 eggs)

3.5 ounces granulated sugar

1/2 teaspoon salt

Photo by [amoon ra](#) on [Unsplash](#)

# Conclusion and Next Steps:

- Built unbiased and biased recommender and would like to evaluate how well it works through collection of survey data (add collaborative filtering in the future)
- Would like to clean the data more to improve the recommender
- Would like to incorporate dish title and ingredients (like chocolate) (through some natural language processing (NLP)), number of ingredients, and meal type (NLP and cleaning likely required) features in the future
- Would like to try a few different nutrient score algorithms
- It would be great to sort recommendation values by diet types and nutritional restrictions people have as well.

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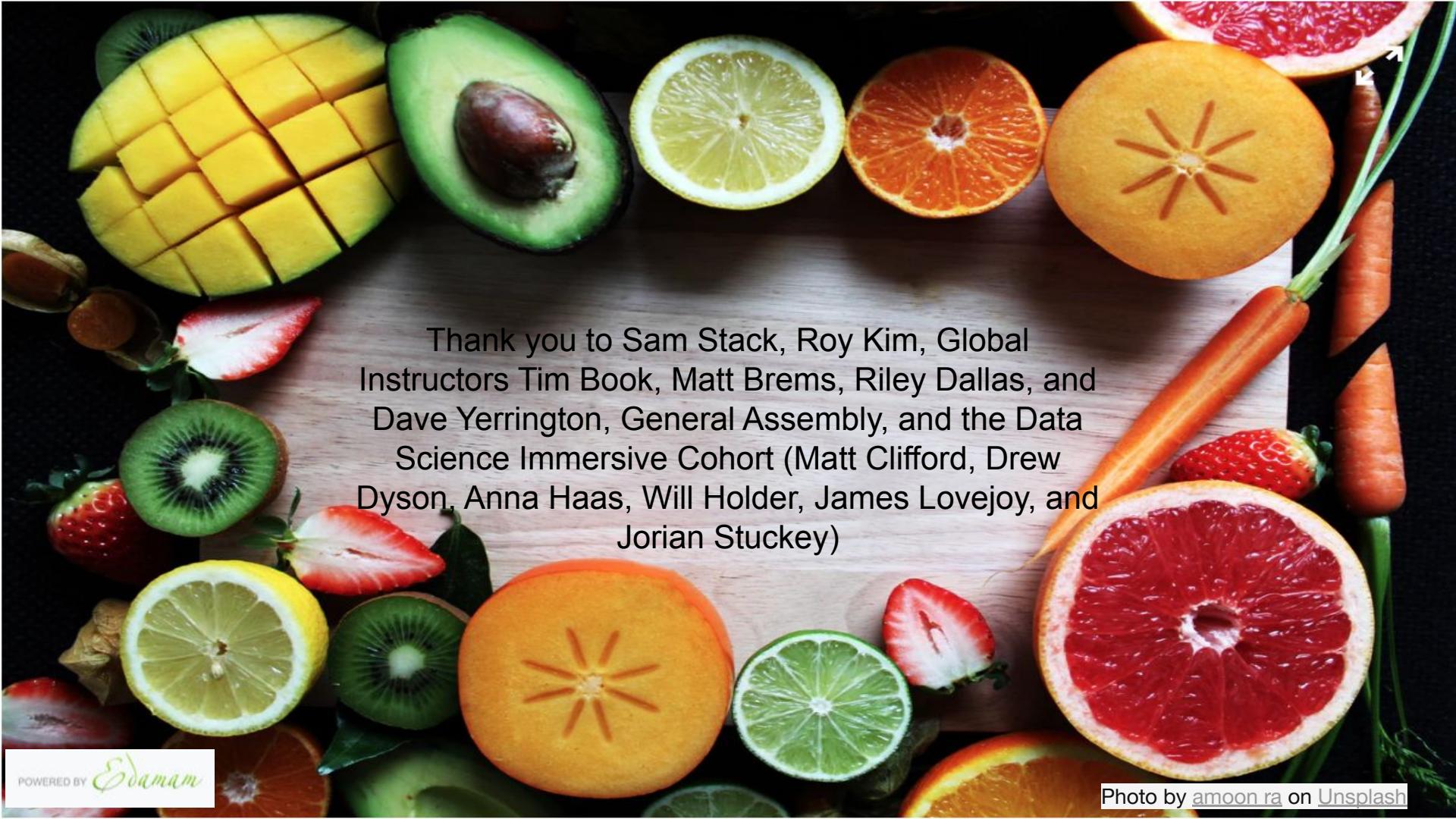
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