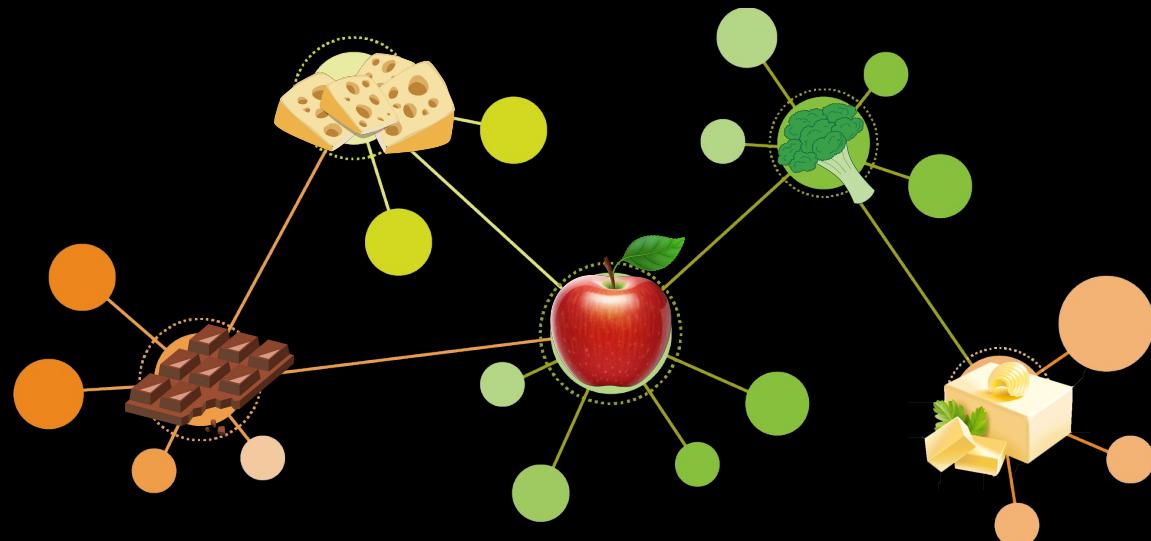


# A NETWORK TOUR OF KITCHEN SCIENCE



Erick Maraz  
Niccolò Stefanini

Lara Orlandic  
Valentin Viennot

# INGREDIENT RECOMMENDATION AND REPLACEMENT

## Motivations

- Adapting recipes to a **specific diet**
- Removing problematic ingredients:
  - **Allergies/Intolerances**
  - **Missing Ingredient**

## Problem

- Brings same **nutritional value**
- **Fits well** in the recipe

## Solution

- Using graph methods: Building an **ingredient network!**



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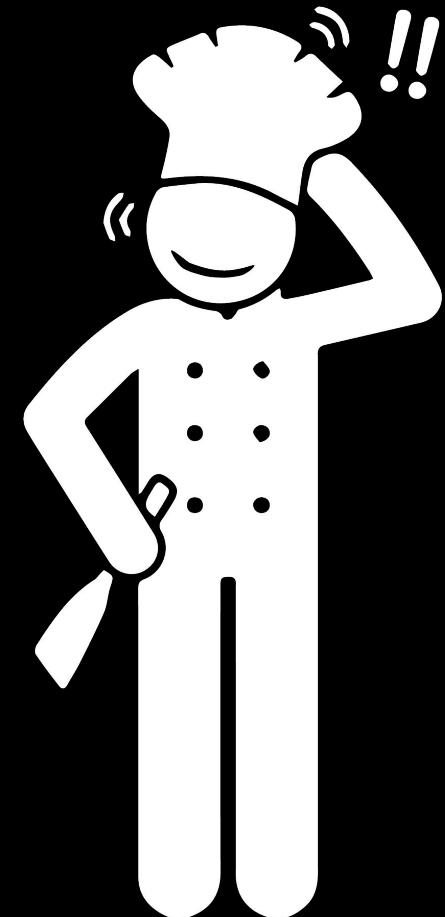
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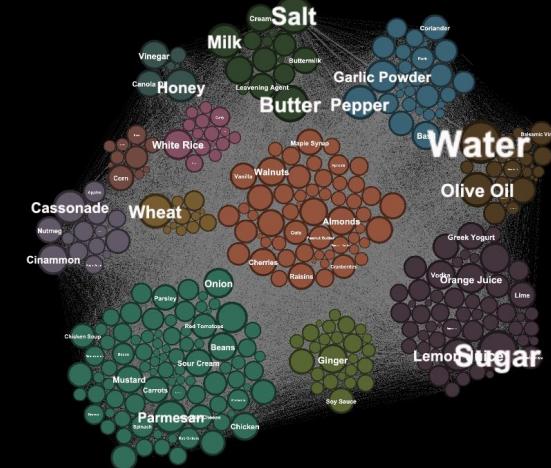
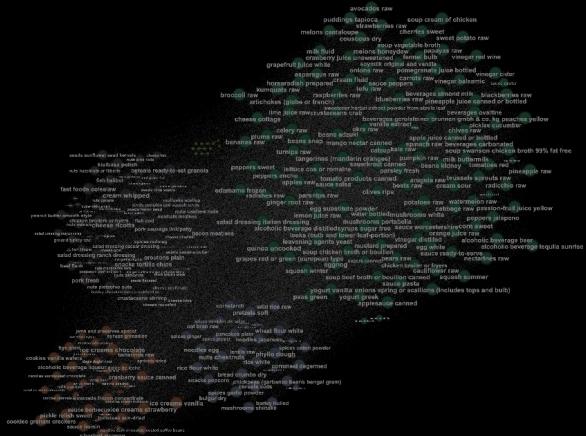
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# DATABASES USED

## Recipe1M+

- Subset of 51k recipes
- Ingredients per recipe
- 357 ingredients in total
- Nutrition facts per recipe



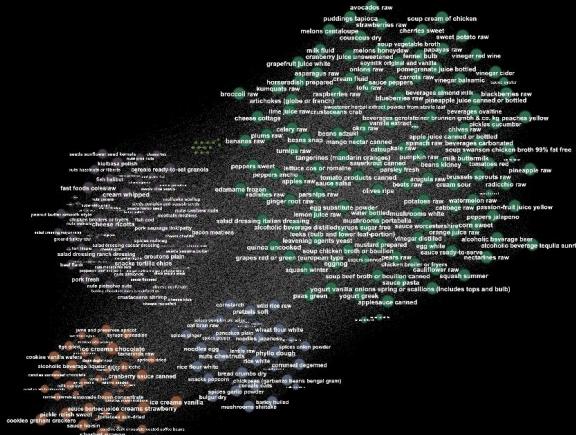
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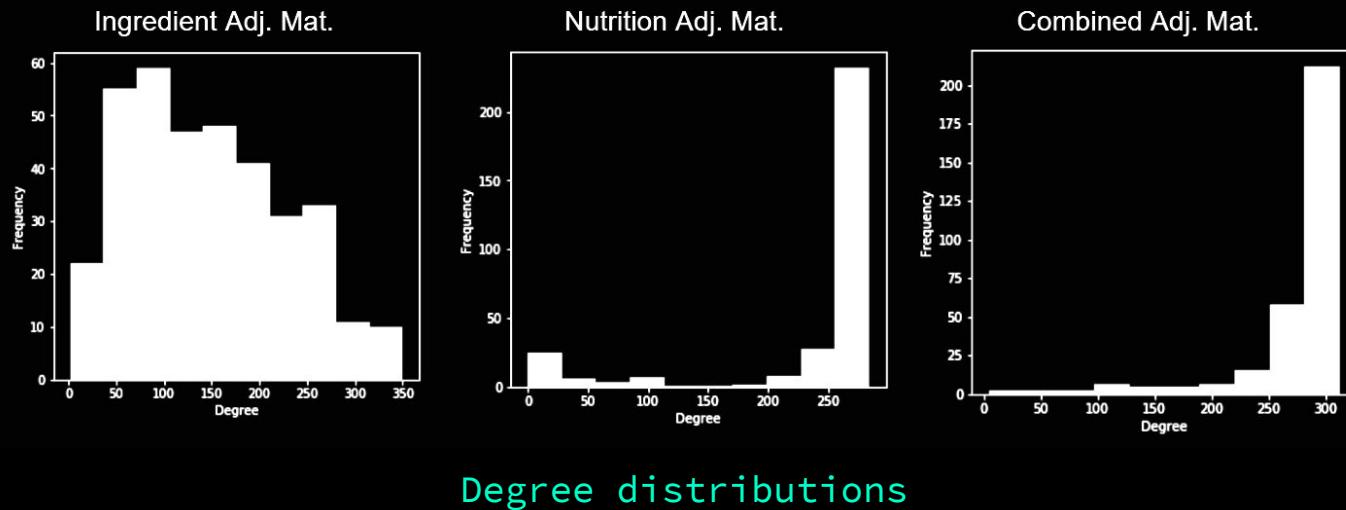
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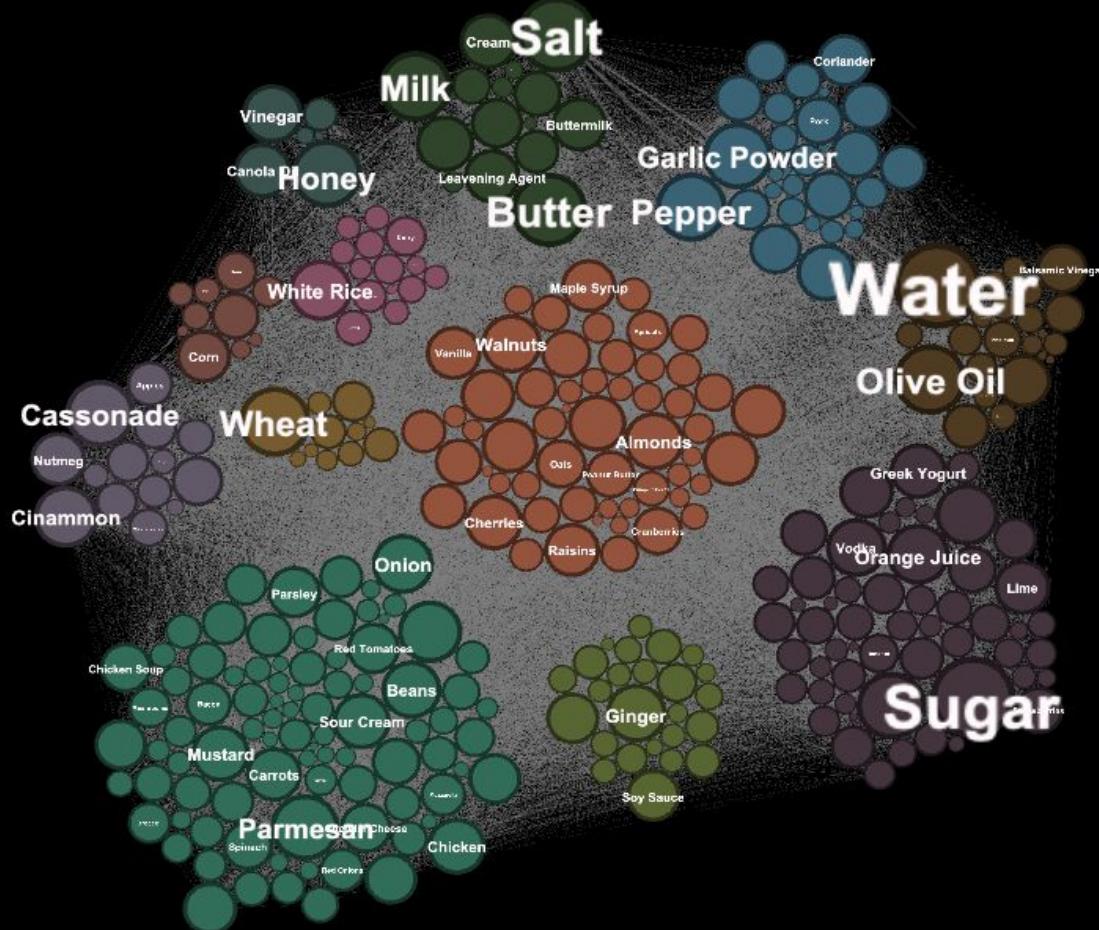
# INGREDIENT NETWORK CREATION

**Nodes = ingredients**

1. **Recipe co-occurrence matrix:** edge weights = # of recipes in which ingredients appear together
2. **Nutrition matrix:** RBF Kernel based on nutrition facts
3. **Combined matrix:** #1 and #2 added together



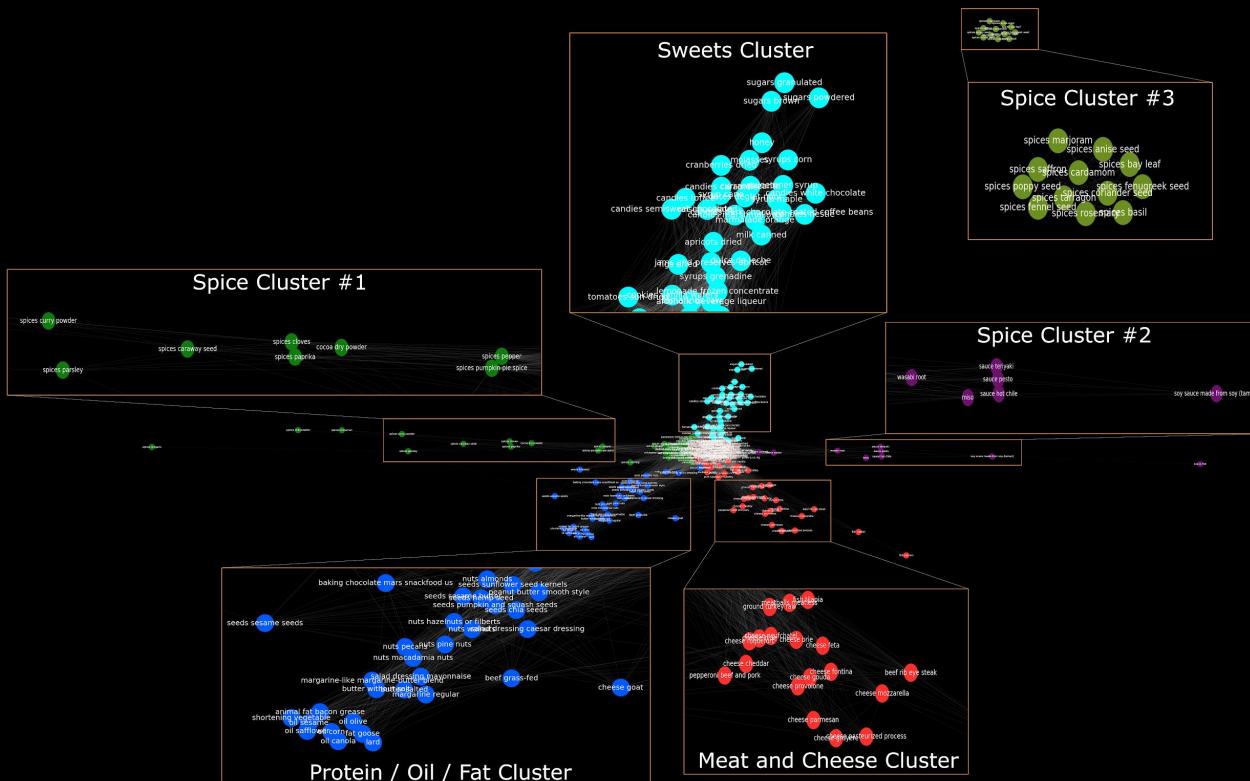
# HUB DETECTION



- Nodes with high centralities
- Ingredients everyone should have in their kitchen

# COMMUNITY DETECTION

- Performed community detection on the nutrition graph using the **Louvain algorithm**
  - Successfully detected distinct category clusters
  - Useful for ingredient substitution



# GRAPH SIGNAL PROCESSING FOR INGREDIENT SUGGESTION

Tested 3 different GSP algorithms:

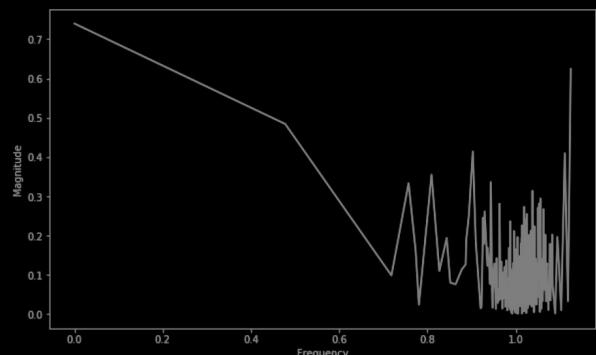
- Graph **shift**

$$\hat{s} = As$$

- Minimizing graph **total variance**

$$\hat{s} = \operatorname{argmin}_{\tilde{s}} \tilde{s}^T L \tilde{s}$$

- Graph **bandpass filter** (passband = [0.8,1.1])



Recipe Signal Fourier Transform

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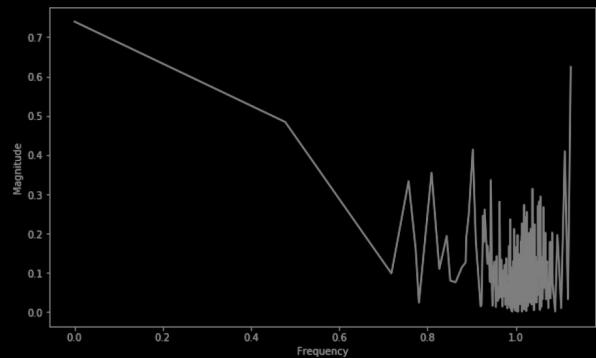
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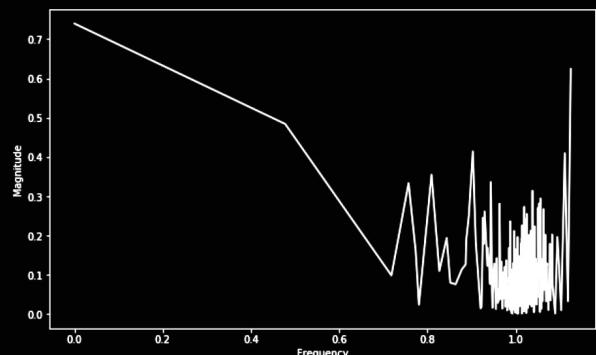
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Recipe Signal Fourier Transform

## Pineapple Ginger Smoothie

### Ingredients



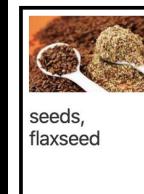
pineapple, raw



spices, ginger



yogurt, vanilla



seeds, flaxseed



orange juice, raw



beverages, almond milk

### Chef's suggestions



seeds, chia seeds



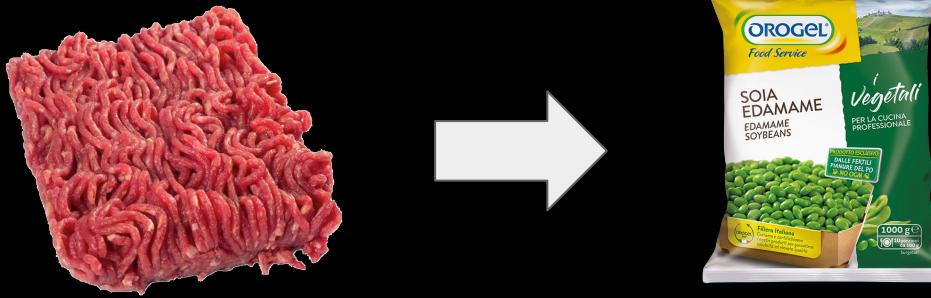
bananas, raw



molasses

# KNN INGREDIENT REPLACEMENT AND "VEGANIZATION"

- Replace ingredients with their k Nearest Neighbors on the nutrition graph
- Replace non-vegan ingredients with vegan ones



Original Ingredient: beef, flank, steak, separable lean and fat, trimmed to 0" fat, all grades, cooked, broiled  
kNN best VEGAN replacements: ['edamame, frozen, prepared'

'tofu, raw, regular, prepared with calcium sulfate'  
'beans, kidney, all types, mature seeds, raw'  
"leavening agents, yeast, baker's, active dry"  
'mushrooms, portabella, raw']

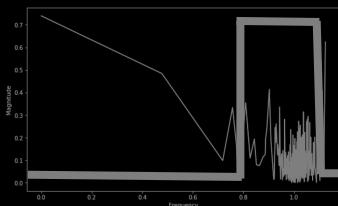
# FINAL INGREDIENT REPLACEMENT ALGORITHM

Represent  
the recipe  
as a binary  
signal



[001101001101]

Apply graph  
bandpass  
filter



[.4 .5 .7 .6 .4]

Choose an  
ingredient to  
replace, find  
kNN  
replacements



Order the  
kNN  
replacements  
using BPF  
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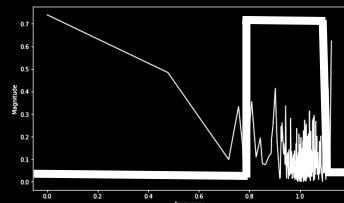
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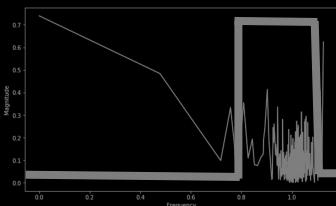
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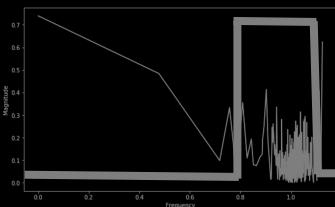
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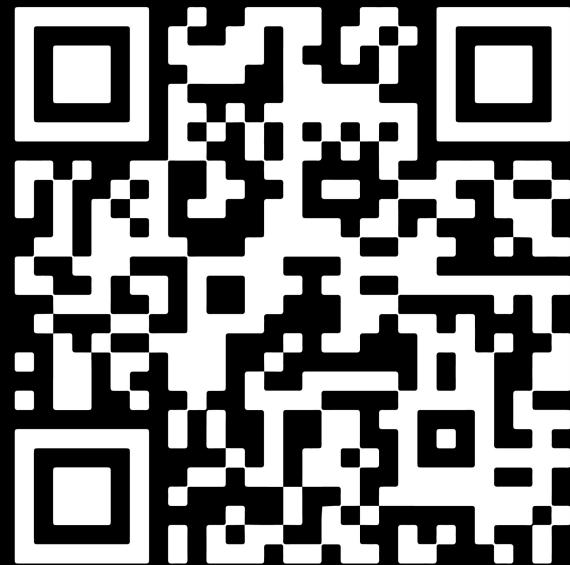


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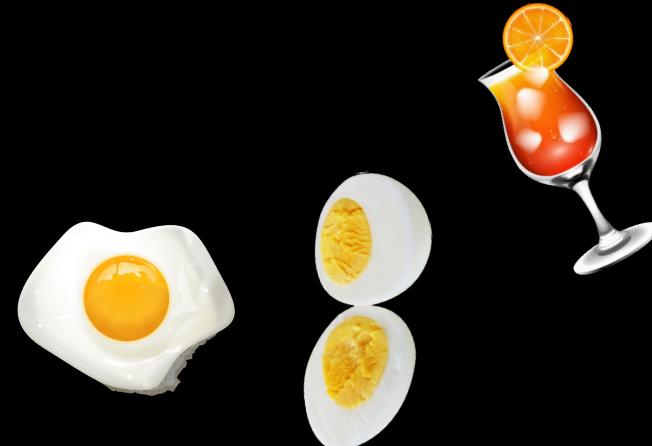
# DEMO!



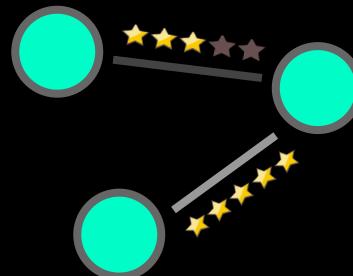
<https://kitchen-science.eu-gb.mybluemix.net/>

# LIMITATIONS (OR FUTURE WORK?)

- No objective measure of outcome success
- Only American recipes (and then ingredients)
- Specific type of recipe
- Ingredient quantity and preparation information
- Combination as replacement
- Not every recipe is good!



$$1+1=1$$



# QUESTIONS?



1. Problem: ingredient replacement
2. Datasets
3. Ingredient network creation
4. Hub detection
5. Community detection
6. Graph signal processing: smooth
7. kNN nutritional replacement
8. Final solution: combo!
9. Limitations



Go to the demo!

THANK YOU FOR YOUR ATTENTION!