Strategic Recipes

EE-558 A Network Tour of Data Science

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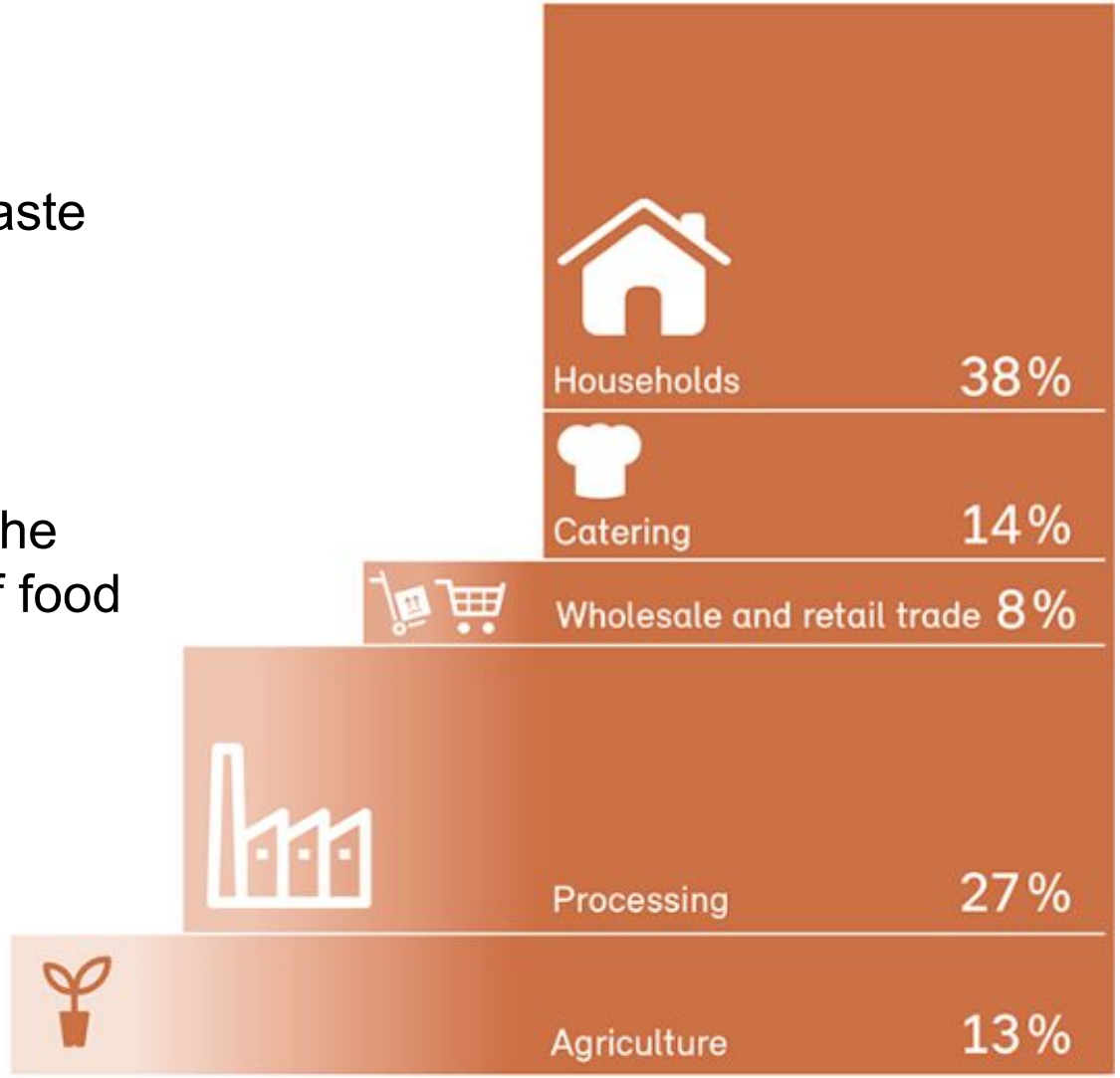
Introduction

- 2.8 million tons of avoidable food waste per year
- 38% by the consumers
- Waste due to lack of awareness of the waste generated and of the value of food



Our Project

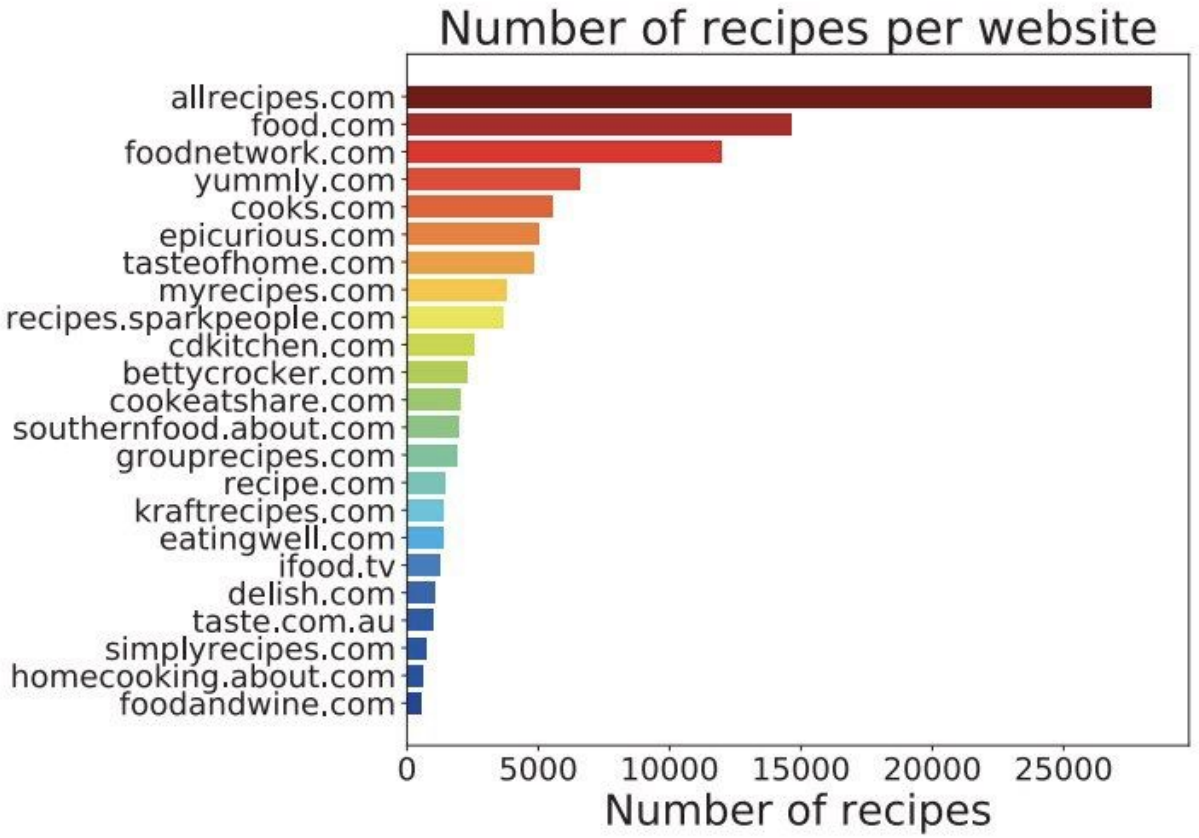
- Implement a product to prevent food waste
- Principle:

  Suggest different recipes trying to:

  Maximize the number of ingredient the consumer already has at home

  Minimize new ingredients to purchase

Getting the Data



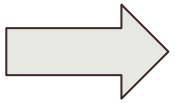
Dataset: cooking recipes

Creating the Graph

- Cleaning the database
  - Removing duplicate ingredients from recipe
  - Removing duplicate recipes
- Keep 2000 first recipes of the database
- Edges weighted by Jaccard Similarity

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

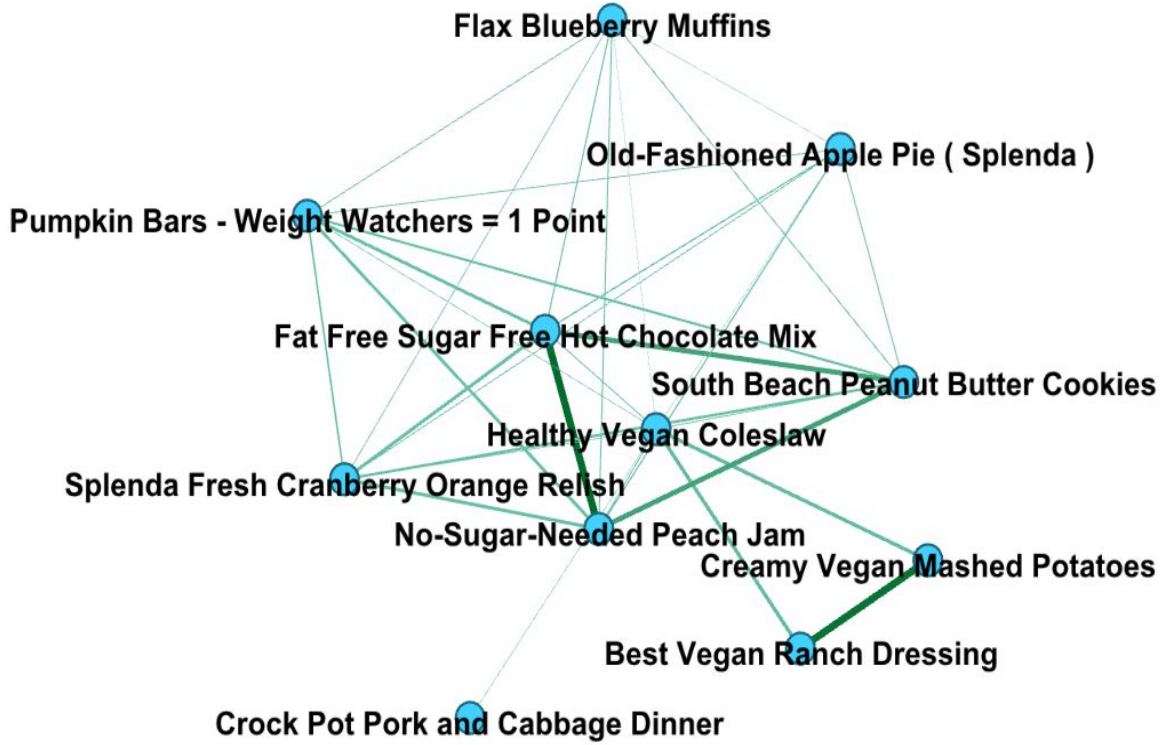
Creating the Graph

- Similarity between all pairs of recipes  Huge number of edges
- Threshold at 0.1

Recipe	Ingredients	Recipe2	Ingredients2	Similarity
Ecuadorean Quinoa and Vegetable Soup	coriander,cumin,green bell pepper,lemon juice,...	Authentic Injera (aka Ethiopian Flat Bread)	salt,teff,water	0.125000
Ecuadorean Quinoa and Vegetable Soup	coriander,cumin,green bell pepper,lemon juice,...	Healthy Vegan Coleslaw	apple cider vinegar,cabbage,mustard,pepper,sal...	0.100000
Ecuadorean Quinoa and Vegetable Soup	coriander,cumin,green bell pepper,lemon juice,...	Grilled Flatbread	active yeast,flour,olive oil,salt	0.117647
Ecuadorean Quinoa and Vegetable Soup	coriander,cumin,green bell pepper,lemon juice,...	Baked Margarita Pie	cracker,milk	0.000000
Ecuadorean Quinoa and Vegetable Soup	coriander,cumin,green bell pepper,lemon juice,...	Lemon Tahini Dressing	garlic clove,lemon juice,soy sauce,tahini,water	0.111111

Creating the Graph

- Subgraph of neighbours of *Healthy Vegan Coleslaw*

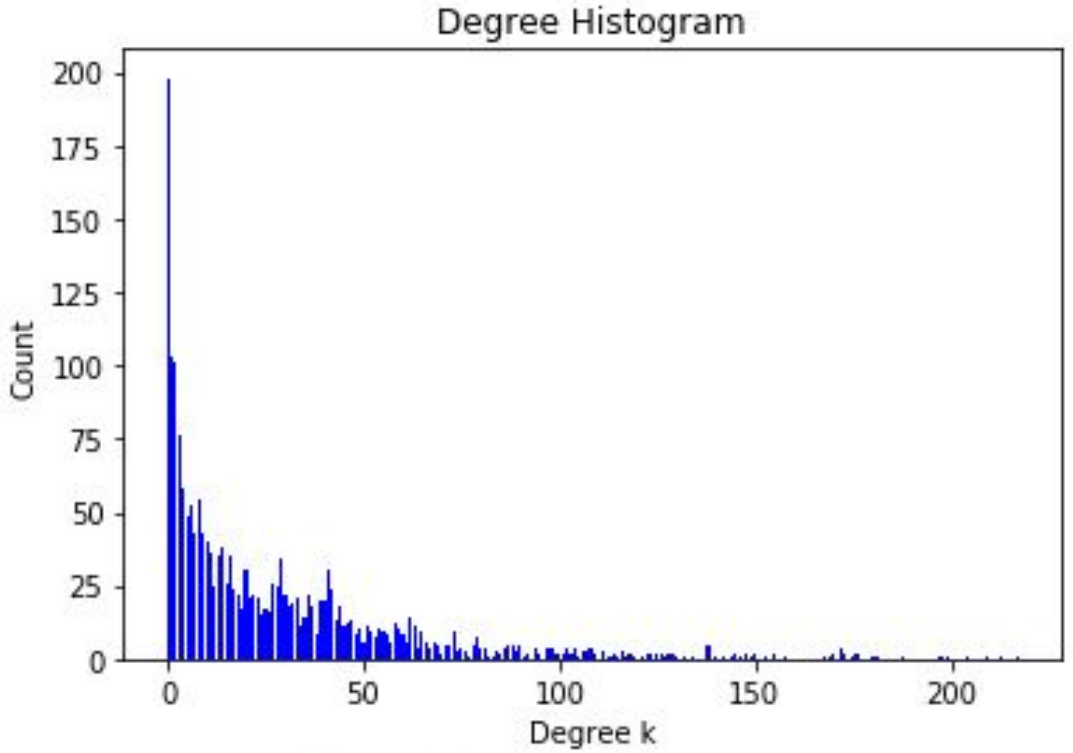


Recipe	Ingredients
No-Sugar-Needed Peach Jam	[splenda granular, water]
Fat Free Sugar Free Hot Chocolate Mix	[splenda granular, vanilla]
Best Vegan Ranch Dressing	[black pepper, garlic powder, onion powder, parsley, soymilk, vegan mayonnaise]
Creamy Vegan Mashed Potatoes	[cayenne pepper, garlic powder, onion powder, potatoes, salt, soymilk, vegan mayonnaise]

Graph properties

- Nodes : **1994**
- Edges : **28’136**
- Average clustering coefficient : **0.4**

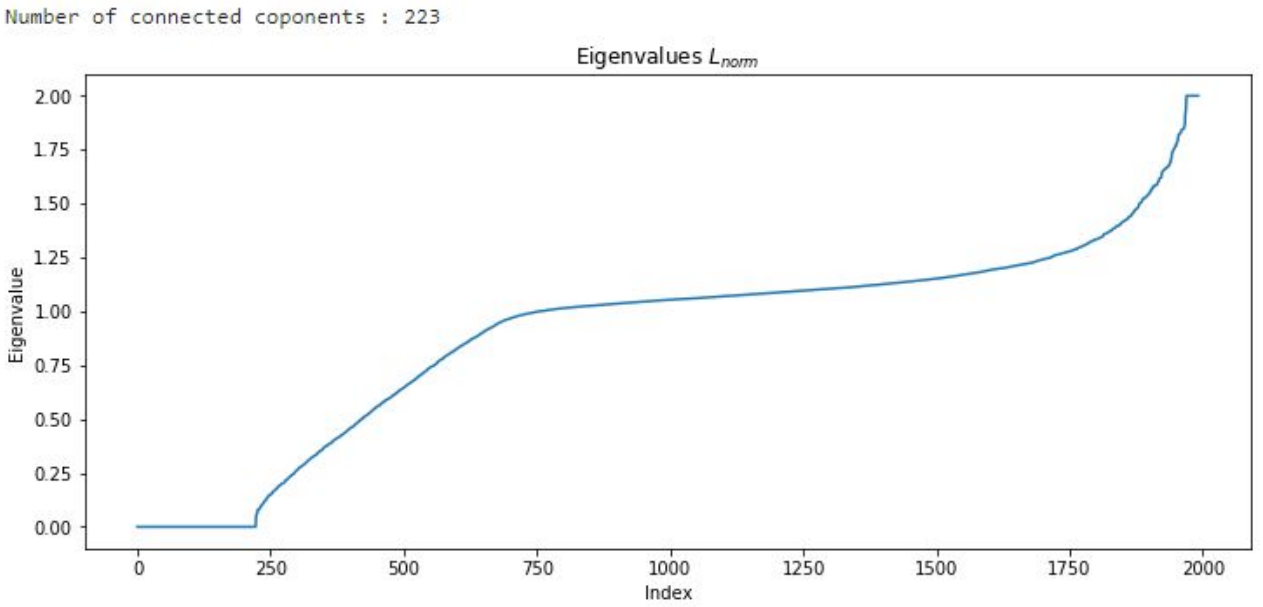
- Degree distribution : **power-law**
- Type of graph : **scale-free**
- k_{min}= 1, k_{max}= 217 $k_{\max} = k_{\min} N^{\frac{1}{\gamma-1}}$
- Curve parameter γ = **2.39**
- **Ultra-small regime** (hubs reduce path length)



Average degree <k> : 28

Spectral decomposition

- Normalized Laplacian for better stability.
- **223** trivial eigenvalues, thus as many connected components
- Eigenvalues bounded at 2 gives plateau at the end
- Small eigenvalue means smooth corresponding eigenvector



Exploitation

- Laplacian Eigenmaps to reduce dimensionality (preserves local distances)
- Then apply spectral clustering

```
Cluster 0 has 537 recipes
{'salt': 216, 'sugar': 153, 'butter': 121, 'egg': 115, 'flour': 108, 'onion': 104, 'water': 102, 'milk': 76, 'olive oil': 69, 'vanilla': 60, 'garlic clove': 52}
Cluster 1 has 403 recipes
{'salt': 167, 'sugar': 131, 'butter': 115, 'flour': 97, 'egg': 80, 'onion': 74, 'water': 66, 'milk': 54, 'vanilla': 51, 'garlic clove': 40, 'black pepper': 39}
Cluster 2 has 402 recipes
{'salt': 142, 'sugar': 107, 'butter': 101, 'onion': 81, 'flour': 77, 'egg': 74, 'water': 73, 'olive oil': 54, 'vanilla': 51, 'black pepper': 44, 'milk': 43}
Cluster 3 has 351 recipes
{'salt': 133, 'sugar': 100, 'butter': 91, 'flour': 68, 'onion': 67, 'water': 55, 'egg': 55, 'garlic clove': 44, 'vanilla': 42, 'milk': 39, 'olive oil': 38}
Cluster 4 has 301 recipes
{'salt': 106, 'sugar': 89, 'butter': 64, 'water': 53, 'onion': 52, 'egg': 48, 'flour': 44, 'vanilla': 40, 'milk': 40, 'olive oil': 32, 'black pepper': 28}
```

- Some clusters share common ingredients
- Having labels for recipes may improve the results
- Clusters different enough to make lists of typical ingredients
- These will be used next to look for a recipe directly in the most promising cluster !

Choose the best cluster

- The input is the ingredient list that the user choose. N = number of ingredients
- Return the representation of each cluster with a size N

```
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{'salt': 216, 'sugar': 153, 'butter': 121, 'egg': 115, 'flour': 108, 'onion': 104, 'water': 102, 'milk': 76, 'olive oil': 69, 'vanilla': 60, 'garlic clove': 52}
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```

- Compute the Jaccard distance between the input and all these representations.
- Choose the cluster with the smallest Jaccard distance

Propose interesting recipes

- The most similar cluster has been found
- Compute the Jaccard distance between the input (ingredient list) and all the recipes in this cluster.
- Return the n (10 by default) recipes with the smallest Jaccard distance as a list called best_recipes.

Filter the proposed recipes

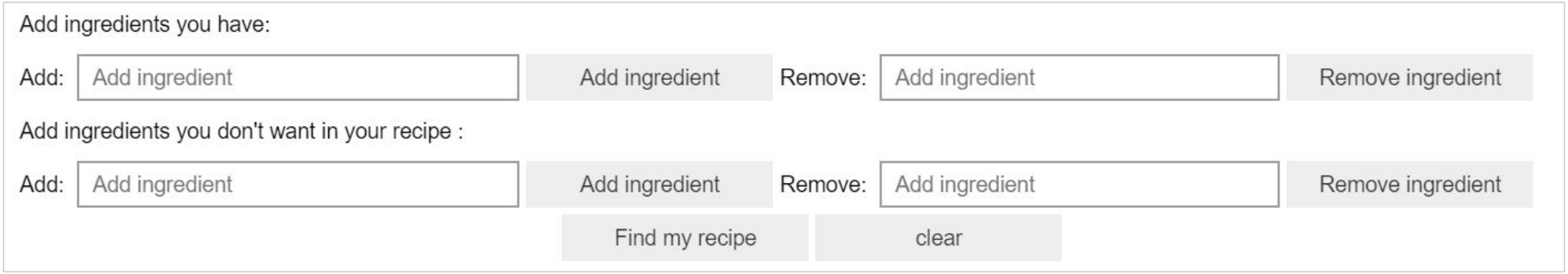
- The user can choose some not wanted ingredients

Algorithm 1: Filtering recipes

```
1) Filter best_recipes ;
while len(best_recipes) == 0 do
    2) n = n + 20;
    3) recompute the best_recipes with size n ;
    4) filter best_recipes
end
```

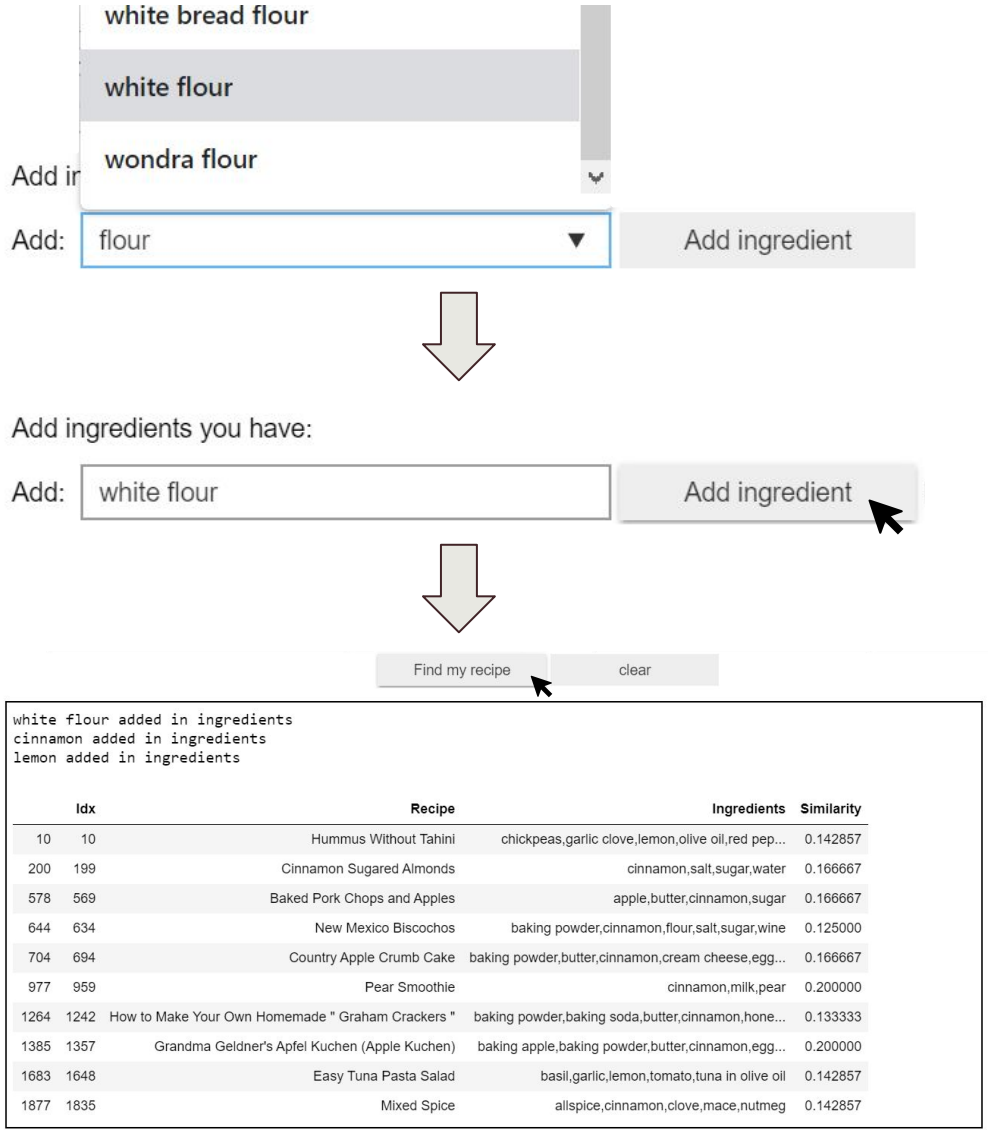
User Interface

- **Combobox:** to find an existing ingredient
- **Buttons “Add”:** to add those ingredient
- **Button “Remove”:** if you added the wrong ingredient
- **Button “Find my recipe”:** to run and find some recipes
- **Button “Clear”:** remove all the elements of the lists



User manual

1. Enter the ingredients that you want to use
2. Enter the ingredient you don't have and don't plan to buy
3. Click on the button "Find my recipe"
4. Enjoy!



	Idx	Recipe	Ingredients	Similarity
10	10	Hummus Without Tahini	chickpeas,garlic clove,lemon,olive oil,red pep...	0.142857
200	199	Cinnamon Sugared Almonds	cinnamon,salt,sugar,water	0.166667
578	569	Baked Pork Chops and Apples	apple,butter,cinnamon,sugar	0.166667
644	634	New Mexico Biscochos	baking powder,cinnamon,flour,salt,sugar,wine	0.125000
704	694	Country Apple Crumb Cake	baking powder,butter,cinnamon,cream cheese,egg...	0.166667
977	959	Pear Smoothie	cinnamon,milk,pear	0.200000
1264	1242	How to Make Your Own Homemade " Graham Crackers "	baking powder,baking soda,butter,cinnamon,hone...	0.133333
1385	1357	Grandma Geldner's Apfel Kuchen (Apple Kuchen)	baking apple,baking powder,butter,cinnamon,egg...	0.200000
1683	1648	Easy Tuna Pasta Salad	basil,garlic,lemon,tomato,tuna in olive oil	0.142857
1877	1835	Mixed Spice	allspice,cinnamon,clove,mace,nutmeg	0.142857

Example

```
beef added in ingredients
black pepper added in ingredients
banana added in ingredients
banana removed from ingredients
cucumber added in unwanted ingredients
```

	Idx	Recipe	Ingredients	Similarity
172	172	Homemade Poultry Seasoning	black pepper,nutmeg,rosemary	0.250000
561	552	Healthy Herb-Pepper Sirloin Steak	basil,beef,black pepper,cardamom,catsup,garlic...	0.285714
573	564	Stove Top Stuffing Meatloaf	beef,stove,turkey,water	0.200000
802	789	Cottage Cheese Enchiladas	beef,black pepper,cheddar cheese,chicken,corn,...	0.181818
926	910	Hidden Valley Ranch Cheeseburgers	beef,cheddar cheese	0.333333
1419	1390	Beef Stir Fry With Green Pepper, Onion & Gravy	beef,black pepper,green pepper,onion,salt,water	0.333333
1429	1400	Bri's Fast Shepherd's Pie	beef,cheddar cheese,mashed potatoes,onion	0.200000
1528	1496	White Queso Dip	black pepper,cheese,chili powder,cumin,salt	0.166667
1637	1605	Kittencal's Easy No-Fail Make Anytime Turkey G...	black pepper,butter,flour	0.250000
1868	1826	Puff Pastry Cheeseburgers	beef,cheddar cheese,flour,pastry,water	0.166667

Let's try it!

Conclusion

- We can apply techniques learned during the lecture to realize a product
- Difficulties:

  Find clear cluster in the data
- To go further

  Add an option to create a menu for the week instead of a recipe for all the ingredients

  Let the user to choose the cooking time

References

Title picture :
https://ec.europa.eu/jrc/sites/jrcsh/files/styles/normal-responsive/public/samael334_adobestock_167843675.jpeg?itok=jyOjNImM

Statistics about food waste in Switzerland:
https://www.bafu.admin.ch/bafu/en/home/topics/waste/guide-to-waste-a-z/biodegradable-waste/types-of-waste/lebensmittelabfaelle.html