

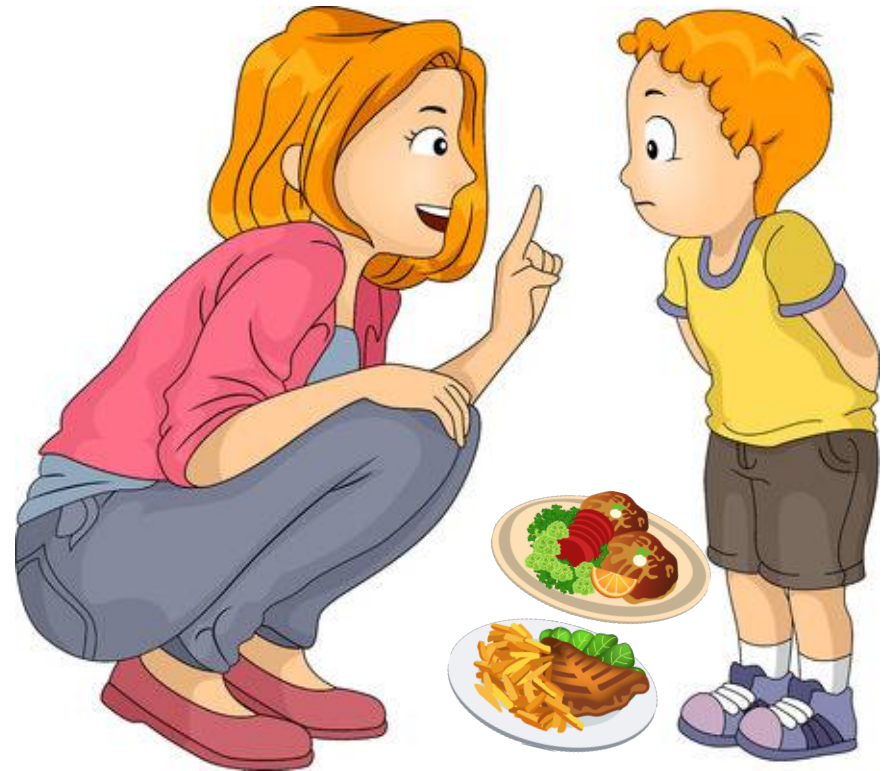
# Recipe Recommendation Reasoning on Features: Ensemble Topic Modeling Based Approach

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# Why food recommendation is interesting ?

Food choice is multifaceted,  
multilevel, contextual,  
dynamic, integrated and  
diverse

-Jeffery Sobal




# Core Challenges in Food/Recipe Recommendation Domain

- Capturing user's preference on food related aspects.
- Identifying coherent content and context information.
- Getting access to standardized food and nutrition data.
- Representation of Food Data
- Mapping health on recommendations.
  - Measuring healthiness of food item.
  - Measure user's nutrient requirement.
- Diversity
- Coverage
- Pursue user to choose healthier options.
- Achieve continuous and regular user engagement.

# What is a recipe?

Low Carb Scalloped Zucchini



1hr15mins 4 Serving Nutrition

**Ingredients**

- 3 medium zucchini: sliced into disks
- 1 egg
- 1 cup cottage cheese
- 1/3 cup red onion
- 1/4 lb diced ham
- 2 teaspoons dried parsley
- 1/2 teaspoon salt
- 1/4 teaspoon garlic powder
- 6 slices bacon

**Instruction**

**Step 1 :** Preheat oven to 350°F.

**Step 2 :** Boil the zucchini in salted water for 5 minutes and then drain really well and pat dry.

**Step 3 :** Mix the egg, cottage cheese, onion, diced ham, parsley, salt and garlic powder together.

**Step 4 :** Spray a 2 quart casserole with nonstick cooking spray and then layer 1/3 of the zucchini in the bottom.

**Step 5 :** Layer 1/2 of the cheesy ham mixture over the zucchini and continue layering until finished off with a top layer of zucchini.

**Step 6 :** Spread the uncooked bacon out over the top and bake for 1 hour at 350°F.

**Nutrition**

Calorie : 299.9  
Calories from Fat : 187  
Total Fat : 20.8g  
Saturated Fat : 7.6g  
Total Carbohydrate : 8.2g  
Sugars : 3.4g  
Dietary Fiber : 1.9g  
Protein : 20.4g  
Cholesterol : 98.6mg  
Sodium : 1249.6mg



## Recipe is a Story : Document

Title: Yummy mashed potatoes

Ingredients: butter, cream, potatoes, salt and pepper

Instruction : cook potatoes in boiling water until tender but still firm, In a small saucepan heat butter and cream at low heat. Using a potato masher slowly blend cream mixture into potatoes. Season with salt and pepper to taste.

# How RS reads a recipe?

Frequency Count :

Occurrence of  
terms in each  
document

Terms	Frequency
Potatoes	4
saucepan	1
heat	2
title	1
.....	
in	2
salt	2
tender	1
a	2

# Recipe 1

Title: Yummy mashed potatoes

Ingredients: potatoes, butter, cream, salt and pepper

Instruction : cook potatoes in boiling water until tender but still firm, In a small saucepan heat butter and cream at low heat. Using a potato masher slowly blend cream mixture into potatoes. Season with salt and pepper to taste.



Bag of word representation



a	in	potatoes	salt	low	Sauce pane	but					masher			blend
2	2	4	2	1	1	1					1			1

# Hundreds of thousands of Documents : Recipe Corpus

Title: Irish stew

Ingredients: chuck lamb stew meat parsnips broth russet potatoes Instruction

Title: Gunnies beef pie

Ingredients: flour beef gunnies butter salt celery beef stock carrot

Title: Yummy mashed potatoes

Ingredients: butter, cream, potatoes salt and pepper

Instruction : cook potatoes in boiling water until tender but still firm, In a small saucepan heat butter and cream at low heat. Using a potato masher slowly blend cream mixture into potatoes. Season with salt and pepper to taste.

Recipe 1, 2, 3



Bag of word representation

Title: Irish stew  
Ingredients: chuck lamb stew meat, parsnips, broth, russet potatoes

Title: Gunnies beef pie  
Ingredients: flour, beef, gunnies, butter, salt , celery , beef stock , carrot

Title: Yummy mashed potatoes  
Ingredients: potatoes, butter, cream, salt and pepper  
Instruction : cook potatoes in bowling water until tender but still firm, In a small saucepan heat butter and cream at low heat. Using a potato masher slowly blend cream mixture into potatoes. Season with salt and pepper to taste.



	a	in	potatoes	salt	low	saucepan	but			beef			lamb
R1	2	2	4	2	1	1	1			0			0
R2	9	5	0	4	0	4	0			2			0
R3	6	4	3	3	0	2	0			0			3

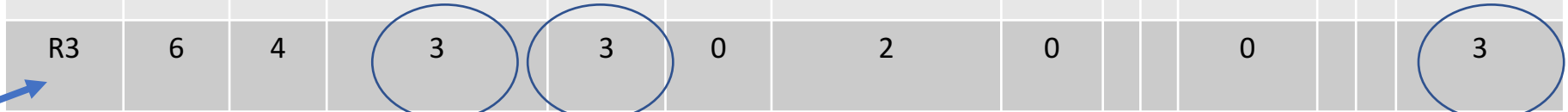
# Recommending recipes

beef recipes

	a	in	potatoes	salt	low	saucepan	but			beef			lamb
R1	2	2	4	2	1	1	1			0			0
R2	9	5	0	4	0	4	0			2			0
R3	6	4	3	3	0	2	0			0			3

# Understanding the relevance weight

	a	in	potatoes	salt	low	saucepan	but			beef			lamb
R1	2	2	4	2	1	1	1			0			0
R2	9	5	0	4	0	4	0			2			0
R3	6	4	3	3	0	2	0			0			3



# Document Frequency: Occurrence of terms over entire corpus

Title: Irish stew  
Ingredients: chuck lamb stew meat, parsnips, broth, russet potatoes

Title: Gunnies beef pie  
Ingredients: flour, beef, gunnies, butter, salt , celery , beef stock , carrot

Title: Yummy mashed potatoes  
Ingredients: potatoes, butter, cream, salt and pepper  
Instruction : cook potatoes in bowling water until tender but still firm, In a small saucepan heat butter and cream at low heat. Using a potato masher slowly blend cream mixture into potatoes. Season with salt and pepper to taste.

Terms	Frequency
Potatoes	7
saucepan	7
heat	9
Title	3
.....	
in	11
salt	9
tender	1
a	17



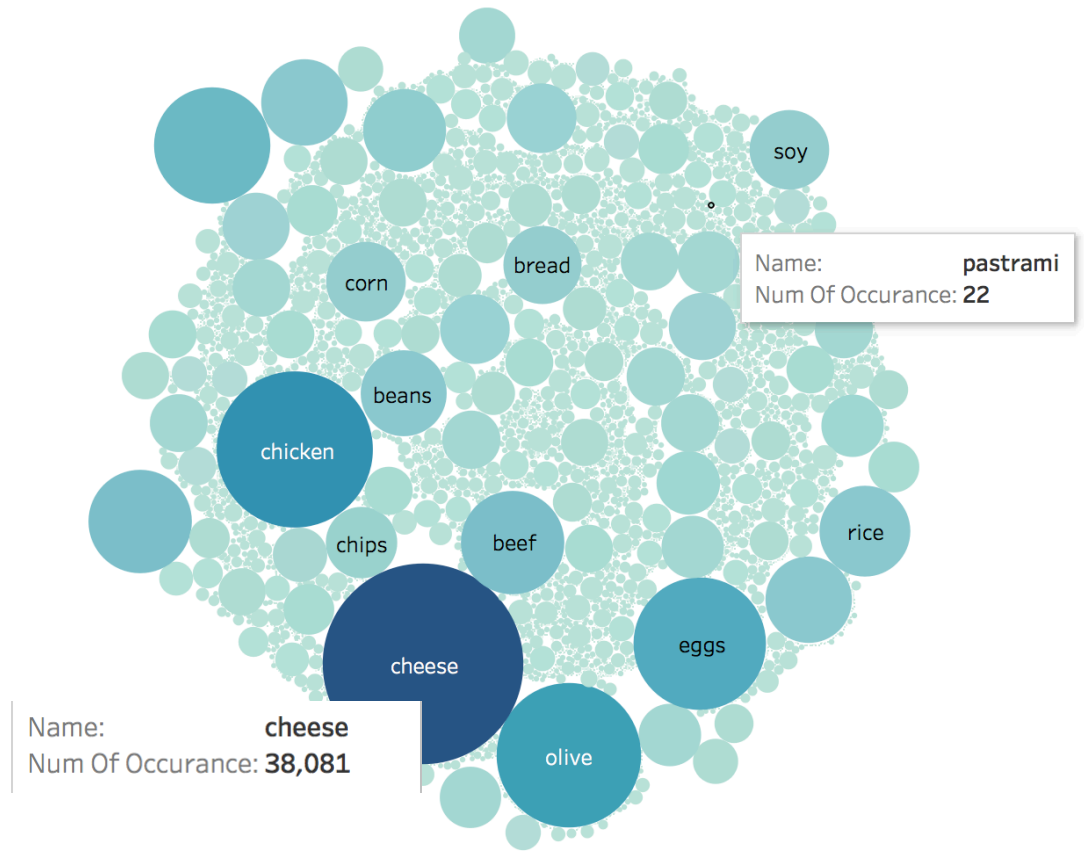
Frequency Matrix

	a	in	potatoes	salt	low	saucepan	but			beef			lamb
R1	2	2	4	2	1	1	1			0			0
R2	9	5	0	4	0	4	0			2			0
R3	6	4	3	3	0	2	0			0			3

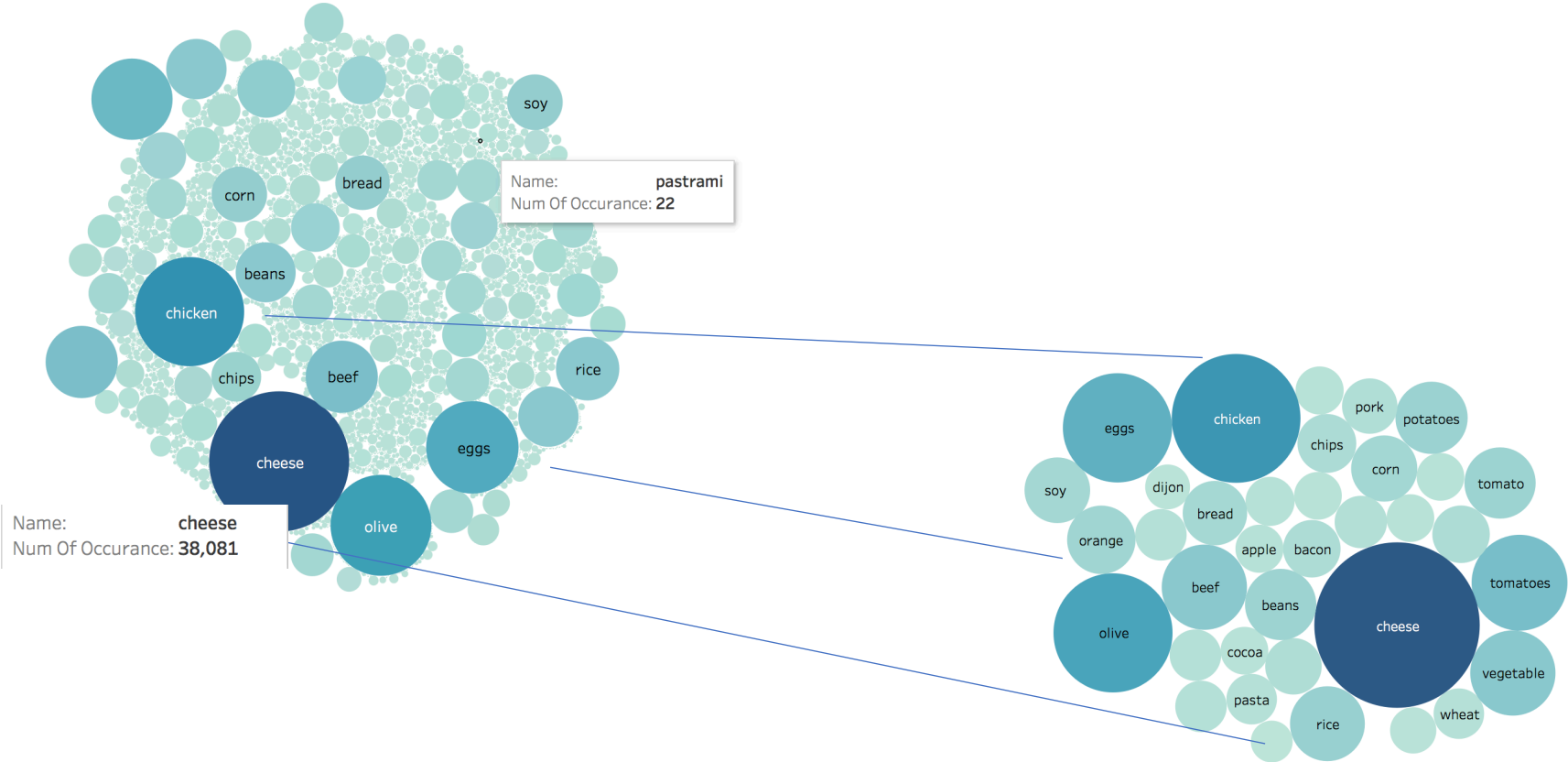
Tf-Idf Matrix

	a	in	potatoes	salt	low	saucepan	but			beef			lamb
R1	0.493	0.871	2.296	1.045	1.477	0.632	1.477	0	0	0	0	0	0
R2	2.220	2.178	0.574	2.091	0	2.528	0	0	0	2.352	0	0	0
R3	1.480	1.742	1.722	1.568	0	1.264	0	0	0	0	0	0	3

- 10,661 ingredients
- 230,872 recipes



# Considering only highly frequent ingredients ?



What information are relevant to Food Recommender?

# Topic Modeling

Topic models aim to discover the latent semantic structure or themes within a corpus of documents, which can be derived from co-occurrences of words across the documents.

-Mark Belford

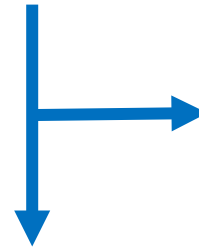
# Topic Model

A topic model typically consists of  $k$  topics, each represented by a ranked list of strongly-associated terms (often referred to as a “topic descriptor”).

	a	in	potatoes	salt	low	saucepan	but	beef	lamb
R1	2	2	4	2	1	1	1	0	0
R2	9	5	0	4	0	4	0	2	0
R3	6	4	3	3	0	2	0	0	3
R4	2	2	4	2	1	1	1	0	0
R5	9	5	0	4	0	4	0	2	0
R6	6	4	3	3	0	2	0	0	3



Topic Modeling



Recipe-Topic Matrix

	Topic <sub>1</sub>	Topic <sub>2</sub>	Topic <sub>3</sub>
R <sub>1</sub>	.5	0	0
R <sub>2</sub>	0	0	0
R <sub>3</sub>	.7	0	0.002
R <sub>4</sub>	0	0	0
R <sub>5</sub>	0	0.3	0.9
R <sub>6</sub>	0	0	0

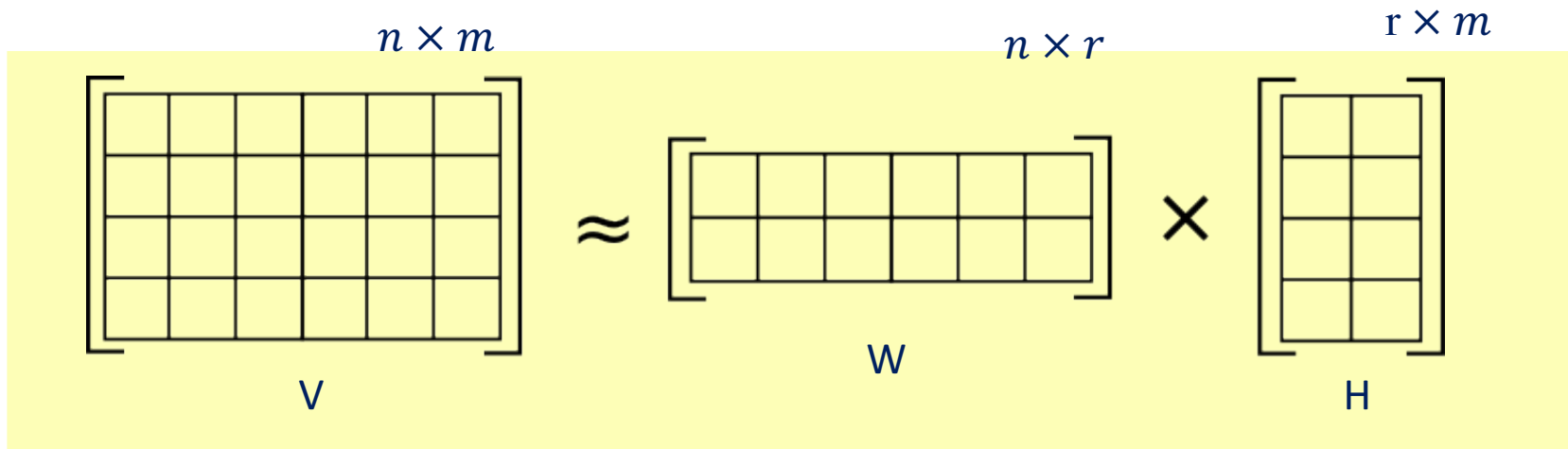
Topic -Term Matrix

	potatoes	saucepan	coco	beef	lamb
Topic <sub>1</sub>	6	.07	0	7	0
Topic <sub>2</sub>	6	1	0	0	4
Topic <sub>3</sub>	0	1	2	0	0

Each document/recipe in the corpus can be associated with one or more topics.



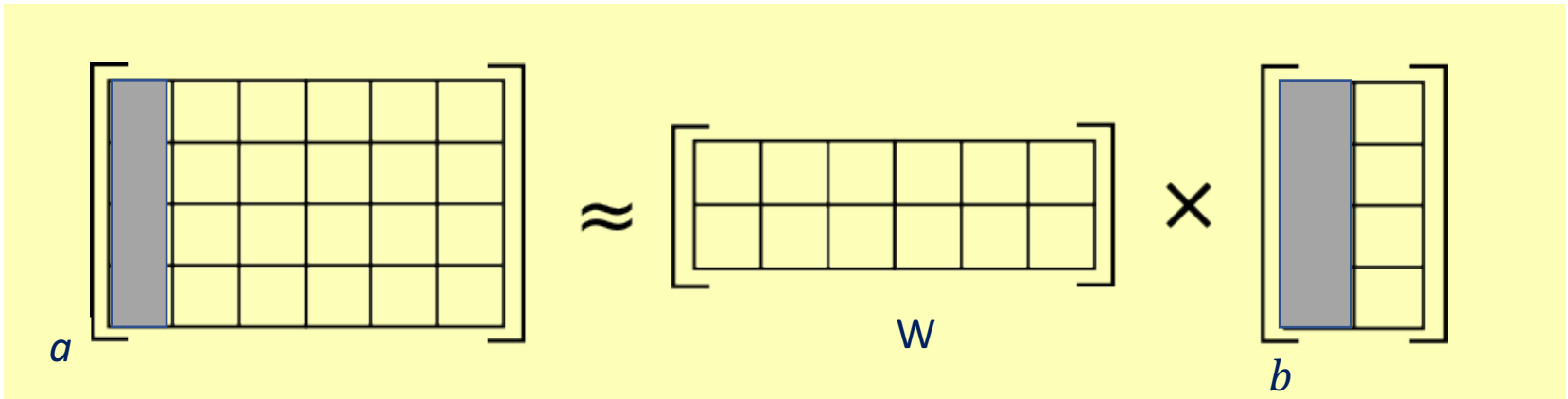
# Non-negative matrix factorization



$$V \approx W \times H$$

It can be rewritten column by column as,

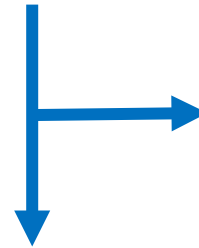
$$a \sim W \times b$$



	a	in	potatoes	salt	low	saucepan	but	beef	lamb
R1	2	2	4	2	1	1	1	0	0
R2	9	5	0	4	0	4	0	2	0
R3	6	4	3	3	0	2	0	0	3
R4	2	2	4	2	1	1	1	0	0
R5	9	5	0	4	0	4	0	2	0
R6	6	4	3	3	0	2	0	0	3



Topic Modeling



Recipe-Topic Matrix

	Topic <sub>1</sub>	Topic <sub>2</sub>	Topic <sub>3</sub>
R <sub>1</sub>	.5	0	0
R <sub>2</sub>	0	0	0
R <sub>3</sub>	.7	0	0.002
R <sub>4</sub>	0	0	0
R <sub>5</sub>	0	0.3	0.9
R <sub>6</sub>	0	0	0

Topic -Term Matrix

	potatoes	saucepan	coco	beef	lamb
Topic <sub>1</sub>	6	.07	0	7	0
Topic <sub>2</sub>	6	1	0	0	4
Topic <sub>3</sub>	0	1	2	0	0

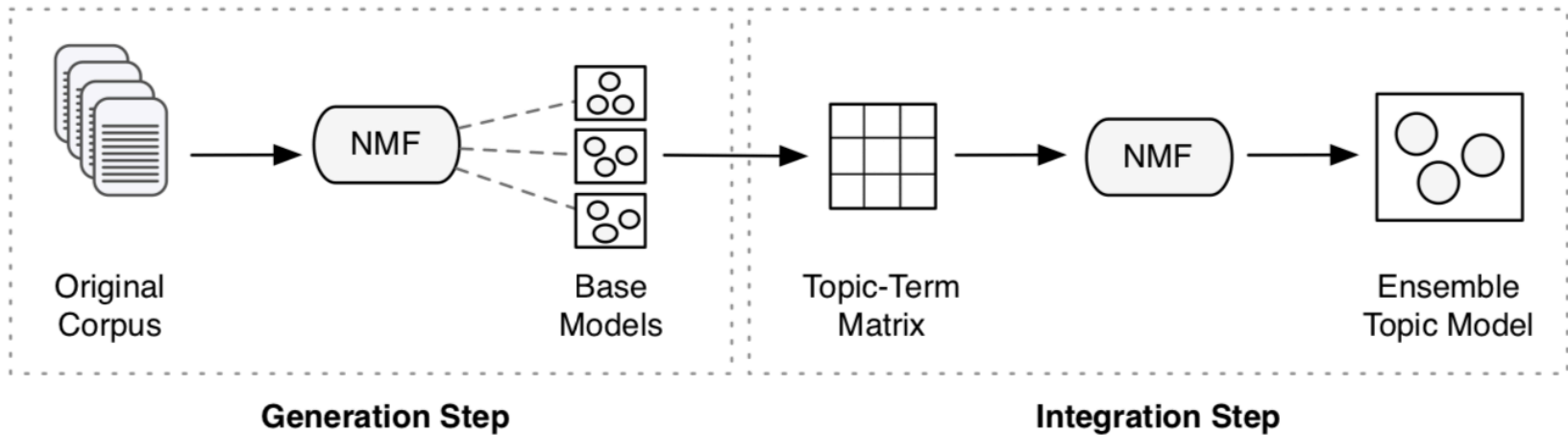
# Outcome of different topic modeling session is only approximately equal

Topic	Terms
Topic 0	beginner-cook, easy, inexpensive, kid-friendly, appetizer, eggs-dairy, holiday-event, snack, toddler-friendly, technique, served-cold, potluck, egg-free, finger-food, european
Topic 1	cheese, eggs-dairy, cheddar, parmesan, appetizer, mozzarella, tortilla, high-calcium, low-carb, cheesecake, macaroni, mayonnaise, feta, goat, lasagna
Topic 2	spinach, olive, feta, artichoke, vegetable, strawberry, parmesan, low-carb, pine, main-dish, salad-dressings, lasagna, tofu, vinaigrette, phyllo
Topic 3	casserole, one-dish-meal, main-dish, sausage, cheddar, noodle, tuna, side-dishes, macaroni, potluck, bubbly, cheese, weeknight, ritz, less-than-half-hour
Topic 4	apple, dessert, low-protein, tart, cranberry, pies-and-tarts, walnut, oat, caramel, applesauce, pecan, maple, pear, batter,salad
Topic 5	dessert, cookies-and-brownies, for-large-groups, cocoa, holiday-event, pecan, almond, bar-cookies, pudding, drop-cookies, christmas, pies-and-tarts, pumpkin, savoury, mixer
Topic 6	vegetable, carrot, side-dishes, zucchini, soups-stews, celery, cabbage, stove-top, asparagus, carrots, cauliflower, pea, pumpkin, mushrooms, green-yellow-beans
Topic 7	corn, tortilla, cornstarch, cornmeal, salsa, cilantro, chowder, cornbread, jalapeno, chilies, cob, ear, popcorn, soups-stews, pecan
Topic 8	rice, side-dishes, soy, white-rice, brown-rice, chinese, basmati, long-grain, pea, one-dish-meal, risotto, pilaf, stove-top, stir-fry, celery
Topic 9	low-cholesterol, low-protein, low-calorie, low-carb, easy, side-dishes, soups-stews, appetizer, strawberry, smoothy, peach, cucumber, technique, savory-sauces, salsa
Topic 10	broccoli, floret, cauliflower, vegetable, mayonnaise, soy, cornstarch, stir-fry, cheddar, chinese, side-dishes, bisques-cream-soups, florets, low-carb, sunflower

Topic	Terms
Topic 0	vegetable, side-dishes, broccoli, spinach, zucchini, asparagus, stove-top, cauliflower, olive, mushrooms, green-yellow-beans, served-hot, soy, beans, cucumber
Topic 1	dessert, cookies-and-brownies, for-large-groups, cocoa, pecan, bar-cookies, holiday-event, drop-cookies, pudding, cooky, walnut, pies-and-tarts, mixer, christmas, hand-formed-cookies
Topic 2	bread, quick-breads, loaf, wheat, rolls-biscuits, low-cholesterol, muffins, small-appliance, for-large-groups, cornmeal, batter, weeknight, high-calcium, coffee-cakes, easy
Topic 3	dessert, apple, low-protein, tart, cranberry, pies-and-tarts, walnut, saur, caramel, applesauce, pecan, maple, pear, batter,salad
Topic 4	chicken, poultry, meat, chicken-breasts, main-dish, low-carb, one-dish-meal, high-protein, chicken-thighs-legs, olive, soy, wing, whole-chicken, easy, weeknight
Topic 5	low-cholesterol, low-protein, low-calorie, low-carb, easy, side-dishes, soups-stews, appetizer, strawberry, smoothy, peach, cucumber, technique, savory-sauces, salsa
Topic 6	beginner-cook, easy, inexpensive, kid-friendly, eggs-dairy, holiday-event, toddler-friendly, snack, technique, served-cold, potluck, egg-free, european, served-hot, south-west-pacific
Topic 7	orange, citrus, cranberry, marmalade, mandarin, holiday-event, tea, oranges, easy, christmas, served-cold, olive, apricot, eel, grapefruit
Topic 8	banana, tropical-fruit, bananas, quick-breads, smoothy, yogurt, muffins, smoothie, walnut, pudding, kid-friendly, wheat, oat, blueberry, batter
Topic 9	almond, blueberry, cherry, raspberry, almonds, peach, coffee, pitted-fruit, yogurt, batter, apricot, yolk, cranberry, european, maraschino
Topic 10	tortilla, appetizer, salsa, cilantro, avocado, jalapeno, mayonnaise, for-large-groups, lettuce, chilies, finger-food, snack, easy, olive, chips

# Ensemble Topic Modeling

Ensemble procedures seek to encourage diversity with a view to improving the quality of the information available in the integration phase  
- Alexander Topchy



# Recipe Recommendation Reasoning on Features : Ensemble Topic Modeling Based Approach

Extracting significant Features(words) using Ensemble Topic modeling

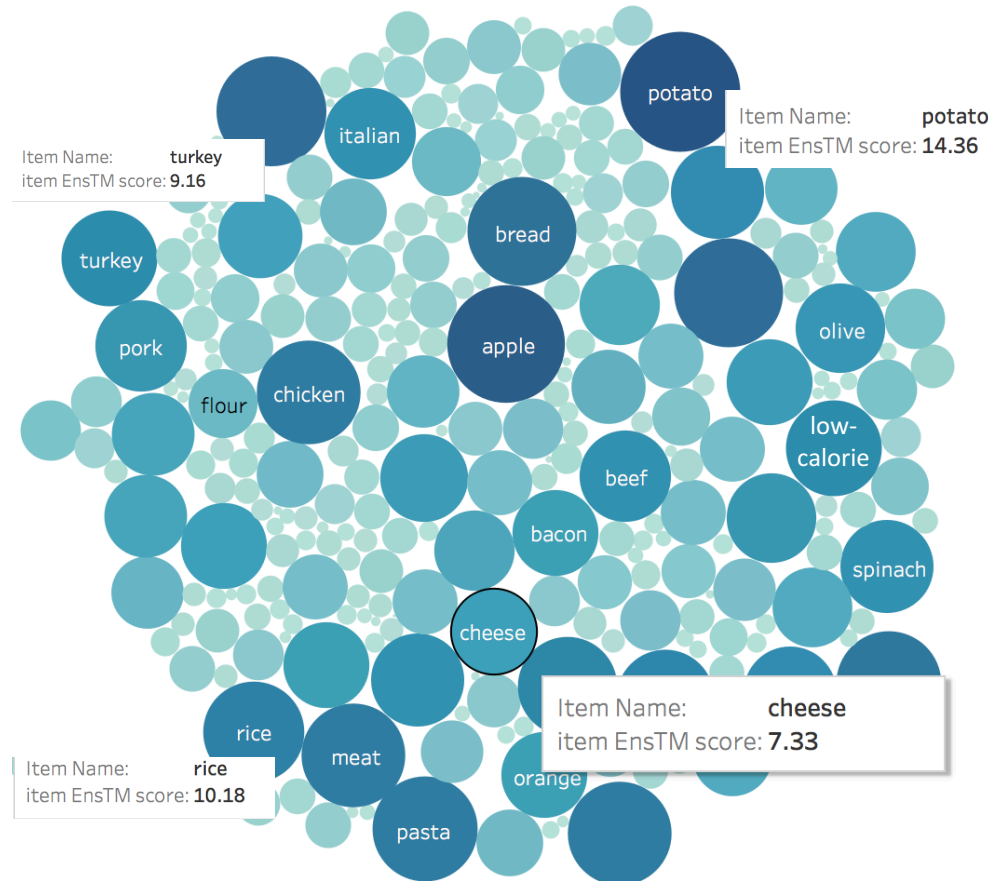
- Tokenize , Lemmatize, Stem , customWord
- Domain and corpus specific Stopwords generation
- Ensemble Topic modeling
- Selecting first 15 words from top 30 topics
- Calculating the weight for the Unique 288 words from the previous step

# Example of identified topics

Topics descriptor	List of 15 features within each topic
Roman	italian, beef-sausage, european, olive, parmesan, mozzarella, pork-sausage, spaghetti, chorizo, pepperoni, lasagna, german, marinara, eggplant, romantic
Banana based dessert and drinks	banana, tropical-fruit, frozen-desserts, quick-breads, smoothie, yogurt, muffins, thermomix, walnut, blueberry, pudding, krispies, wheat, bran, batter
Easy and quick snacks	beginner-cook, easy, inexpensive, kid-friendly, appetizer, eggs-dairy, holiday-food, pretzel, toddler-friendly, few-ingredients-recipe, served-cold, potluck, egg-free, finger-food, served-hot
Easy fish mains	salmon, fish, saltwater-fish, seafood, main-dish, high-protein, spinach, low-carb, vinaigrette, cream-cheese, halibut, dijon, asparagus, chickpeas, beginner-cook
Corn based maxican	tortilla, cornstarch, cornmeal, casserole, salsa, chowder, cornbread, cilantro, jalapeno, chilies, cob, sweet-corn, popcorn, soups-stews, roma-tomato
Rice dishes	rice, side-dishes, white-rice, soy, casserole, brown-rice, chinese, one-dish-meal, basmati, long-grain, pea, risotto, pilaf, stir-fry, stove-top
Tropical juice and desserts	pineapple, tropical-fruit, cherry, hawaiian, mango, maraschino, carrot, low-protein, cornstarch, dessert, soy, pudding, marshmallow, easy, caribbean
Beef based mains	beef, meat, ground-beef, main-dish, one-dish-meal, roast-beef, sirloin, crock-pot-slow-cooker, meatloaf, casserole, meatball, scallion, noodle, breadcrumb, easy
Vegetable dishes	vegetable, carrot, saucepan, zucchini, spinach, soups-stews, tofu, cabbage, sunflower-oil, asparagus, week-night, chickpeas, cauliflower, hard-boiled-egg, mushroom
Seafood mains	seafood, soy-sauce, shellfish, tuna, appetizer, main-dish, wok, low-carb, leek, crabmeat, olive, cod, high-protein, easy, cream-style
Turkey mains	turkey, meat, cooking-wine, main-dish, couscous, thanksgiving, turkey-breasts, tortilla, sausage, lettuce, cranberry, one-dish-meal, burger, gravy, casserole
Health conscious	low-cholesterol, low-protein, low-calorie, ow-carb, easy, side-dishes, soups-stews, appetizer, smoothie, few-steps-recipe, cucumber, egg-free, savory- -appliance, salsa

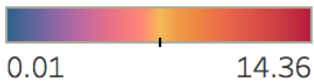
# The final 288 Food Features

Which we later considered the basis of new data representation format and thereby recommendation algorithms

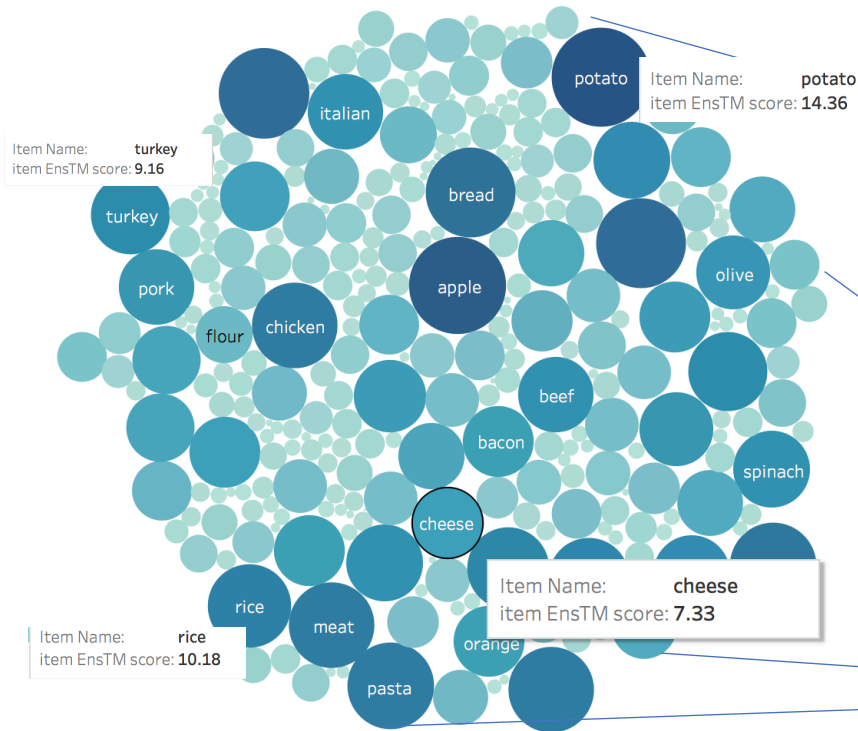




# The final 288 Food Features

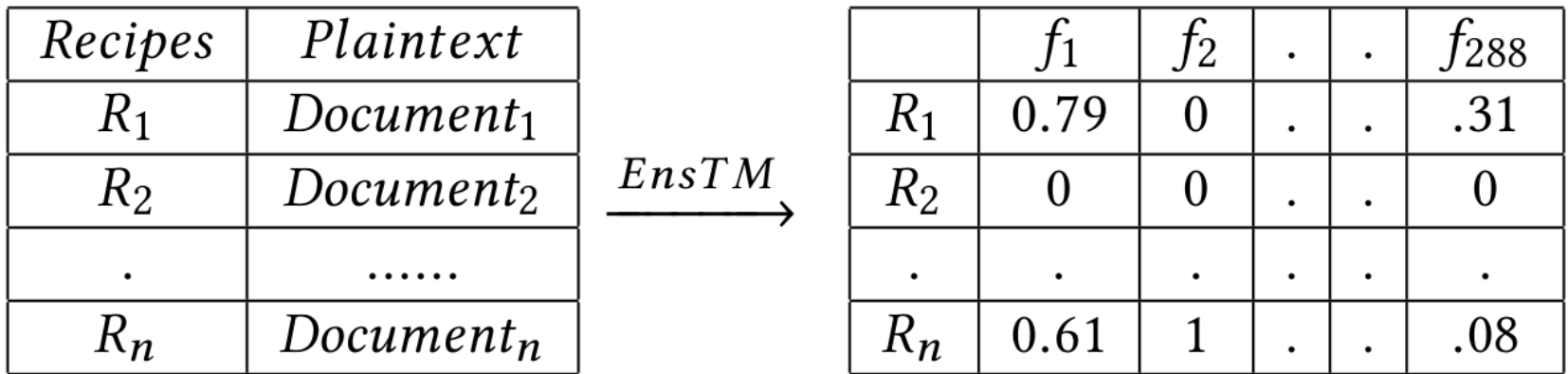


# The final 288 Food Features



	%	Features
context	4.2	holiday-food, beginner-cook, week-night, inexpensive, 6-people-or-more, potluck
cuisine	6.7	italian, hawaiian, tex-mex, chinese, cajun
equipment	2.4	saucepan, thermomix, wok, dutch-oven
cooking process	3.12	few-steps-recipe, less-than-one-hour, fried, slow-cooked, marinated, 4-hours-or-more
ingredient	61.15	poultry, feta, spaghetti, shredded-mea
category	15.2	risotto, lasagna, stew, appetizer, pot-roast
nutrition	3.01	high-calcium, low-cholesterol, egg-free

# Our proposed n-by-288 data representation format



# Recommendation approaches

## Food Features based Recommendation (FFbR)

- $u_a$  is an user
- $r_n$  is a new recipe
- $i$  is each feature in  $r_n$   $i=0,1,2,\dots,m$
- $f_{i,u_a}$  is  $u_a$ 's rating on  $i$

$$P(u_a, r_n) = \left( \sum_{i=0}^m f_{i,u_a} \right)^{(0,5)}$$

# Recommendation approaches

## Weighted Food Features based Recommendation (WFFbR)

- $u_a$  is an user
- $r_n$  is a new recipe
- $i$  is each ingredient in  $r_n$   $i=0,1,2,\dots,m$
- $f_{i,u_a}$  is  $u_a$ 's rating on  $i$
- $w_i$  is significance score of each feature

$$P(u_a, r_n) = \left( \sum_{i=0}^m f_{i,u_a} \times w_i \right)^{(0,5)}$$

## Recommendation approaches

### Food Features based Collaborative Filtering (FFbCF)

- $u_a$  is an user
- $i$  is each neighbor of  $u_a$   $i=0,1,2,\dots,n$
- $f_{b,i}$  is neighbor  $i$ 's rating on a feature  $f_b$
- We calculate  $f_{r,ua}$  using FFbR after learning  $u_a$ 's rating on all unknown feature  $f_b$  using FFbCF

$$P(f_b, u_a) = \frac{\sum_{i=0}^n f_{b,i}}{n}$$

# Recommendation approaches

## Content Based(CB)

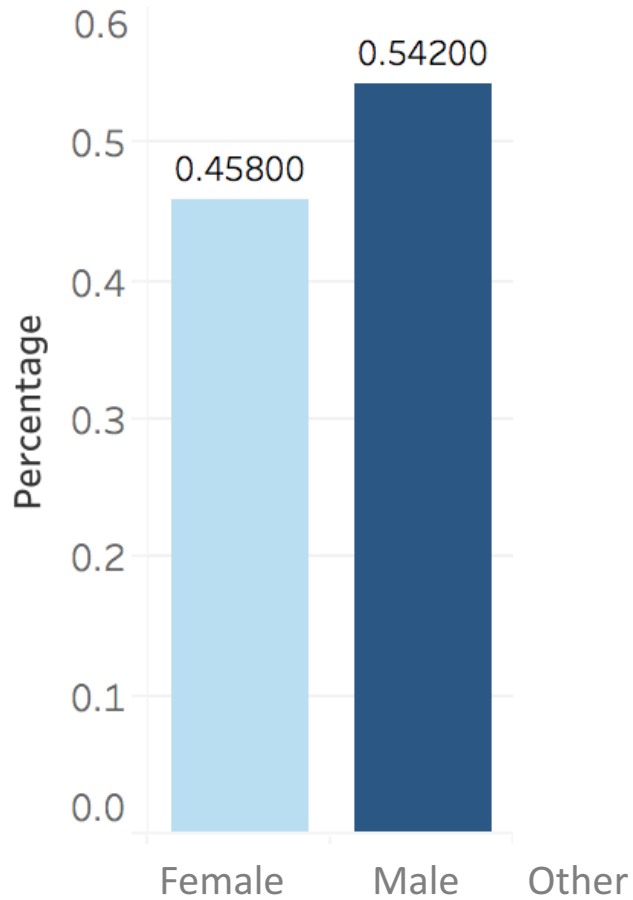
- $u_a$  is an user
- $r_n$  is a new recipe
- $i$  is each ingredient in  $r_n$   $i=0,1,2,\dots,m$
- $Ing_{i,ua}$  is  $u_a$ 's rating on  $i$

$$P(u_a, r_n) = \frac{\sum_{i=0}^m Ing_{i,ua}}{m}$$

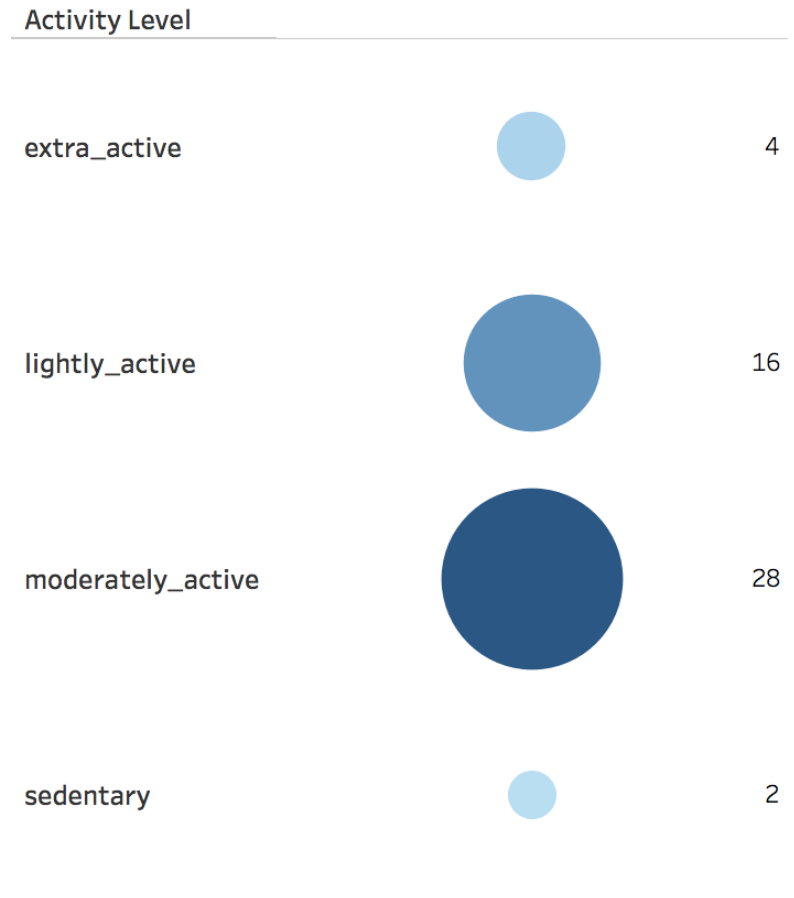
# User modeling and testing the recommendation algorithms



# User Study : 4 recommenders and 48 user

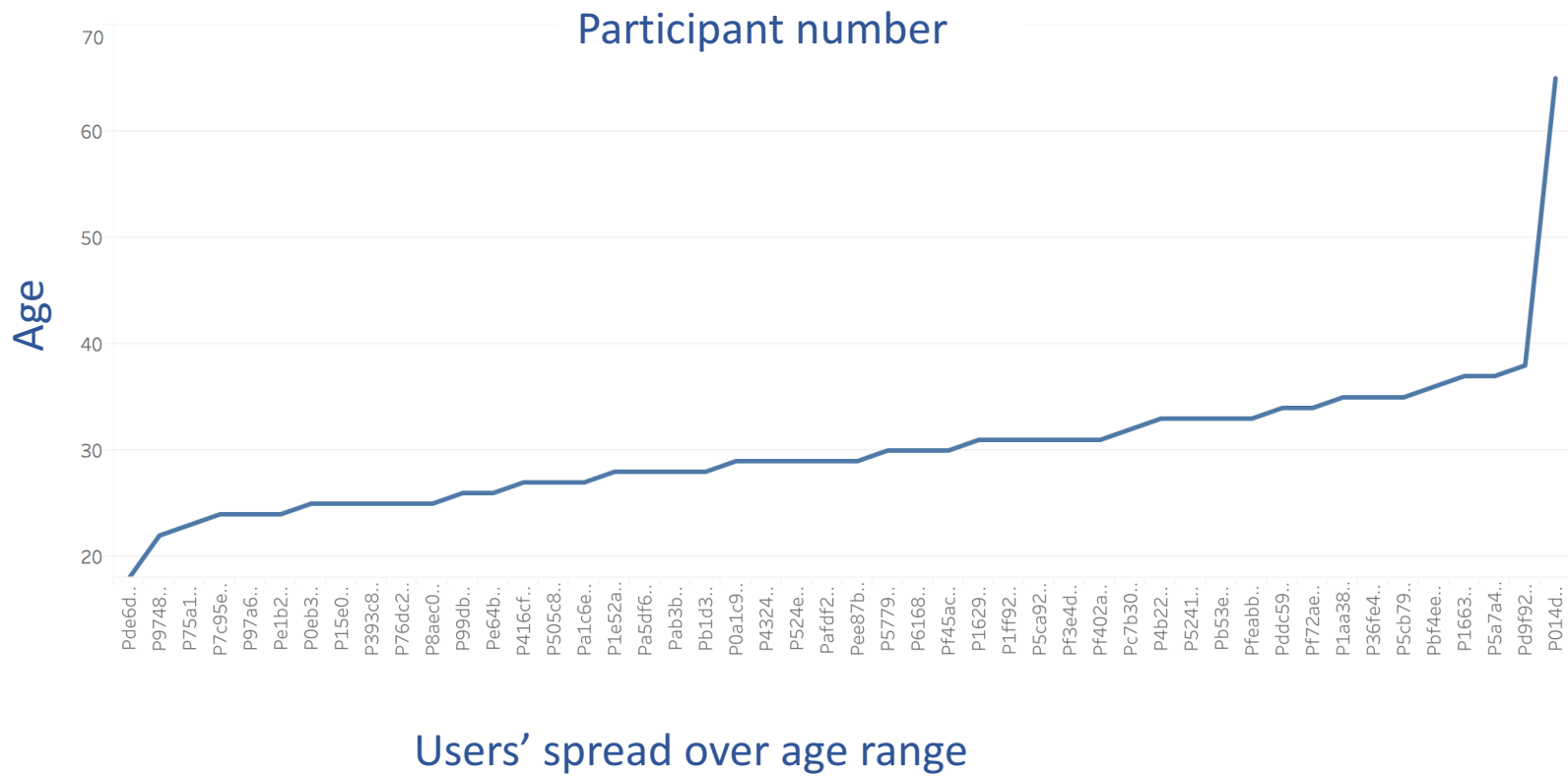


Users' spread over gender category



Users' spread over activity category

# User Study : 4 recommenders and 48 user



# User Study : 4 recommenders and 48 user

localhost:4003/signUP#/. x +  
localhost:4003/signUP#/concent/personalInfo

## Please insert the following infomation

Age 18 100 34

Weight (in kg) 01 150 80

height ( in cm) 31 224 174

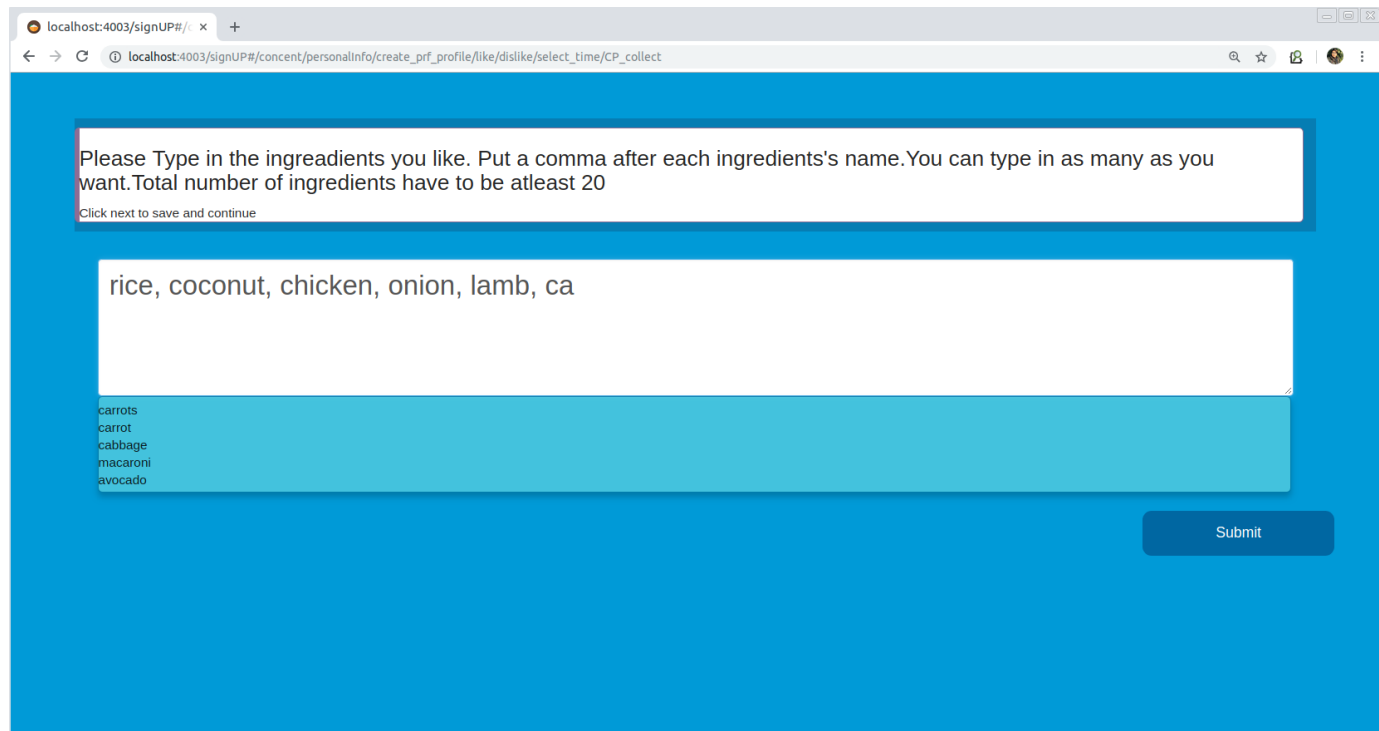
Gender

- Male
- Female
- Other

How would you describe your everyday activity level ?

- Sedentary
- Lightly Active
- Moderately Active
- Very Active

# User Study : 4 recommenders and 48 user



The screenshot shows a web browser window with the address bar displaying "localhost:4003/signUP#/. x +". The page content is on a blue background and contains a white text box with instructions: "Please Type in the ingrediants you like. Put a comma after each ingredients's name.You can type in as many as you want.Total number of ingredients have to be atleast 20". Below this is a "Click next to save and continue" link. A larger white text input field contains the text "rice, coconut, chicken, onion, lamb, ca". Below the input field is a light blue list of suggestions: "carrots", "carrot", "cabbage", "macaroni", and "avocado". A dark blue "Submit" button is located at the bottom right of the form area.

localhost:4003/signUP#/. x +

localhost:4003/signUP#/concent/personalInfo/create\_prf\_profile/like/dislike/select\_time/CP\_collect

Please Type in the ingrediants you like. Put a comma after each ingredients's name.You can type in as many as you want.Total number of ingredients have to be atleast 20

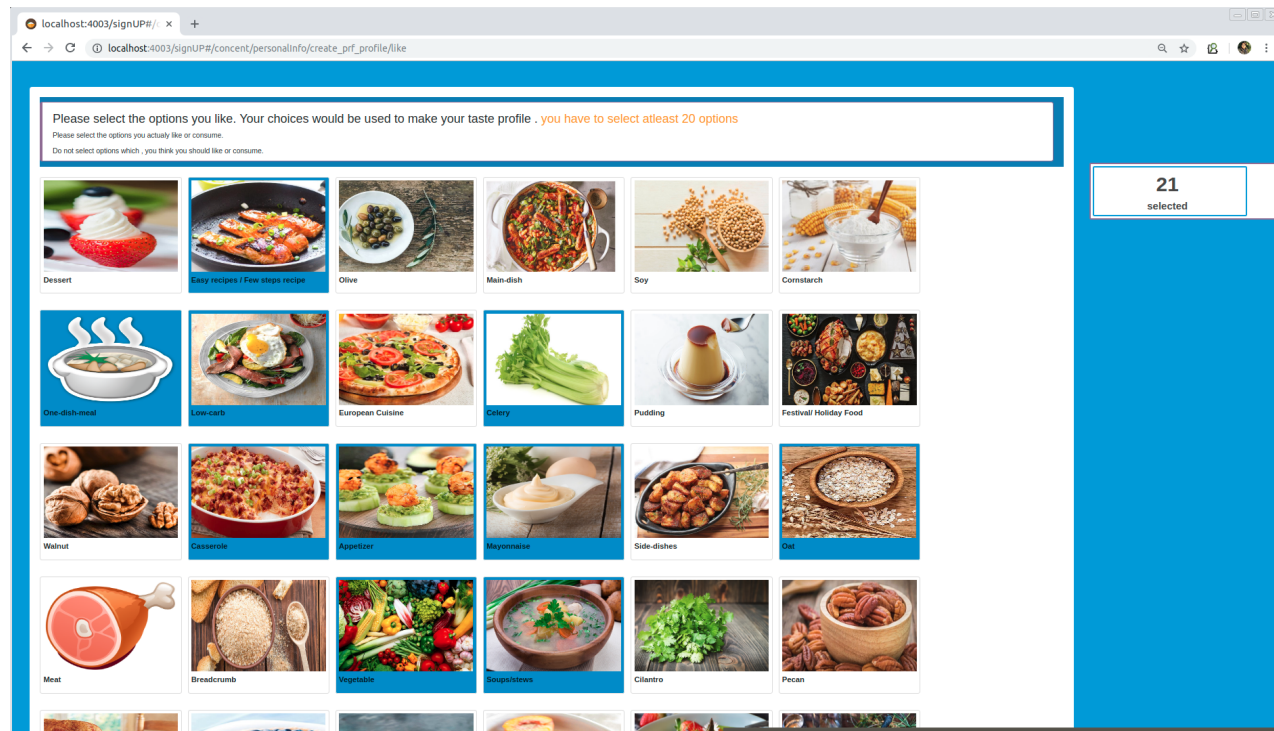
[Click next to save and continue](#)

rice, coconut, chicken, onion, lamb, ca

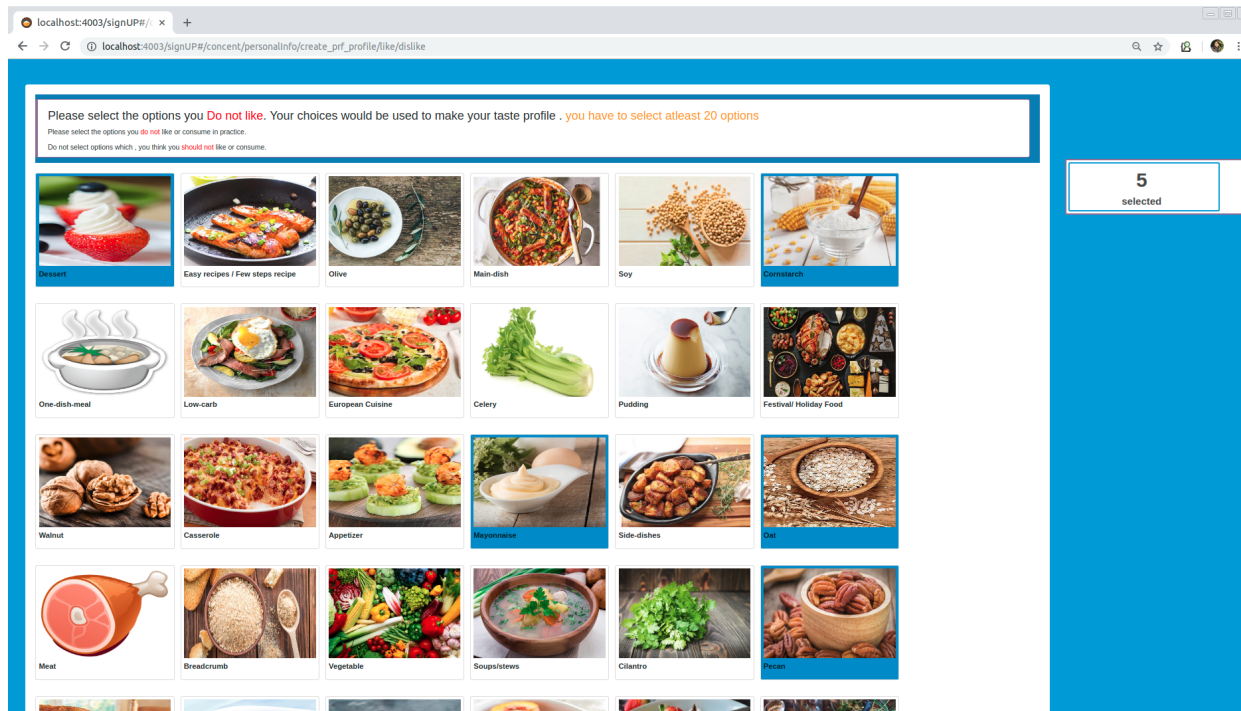
- carrots
- carrot
- cabbage
- macaroni
- avocado

Submit

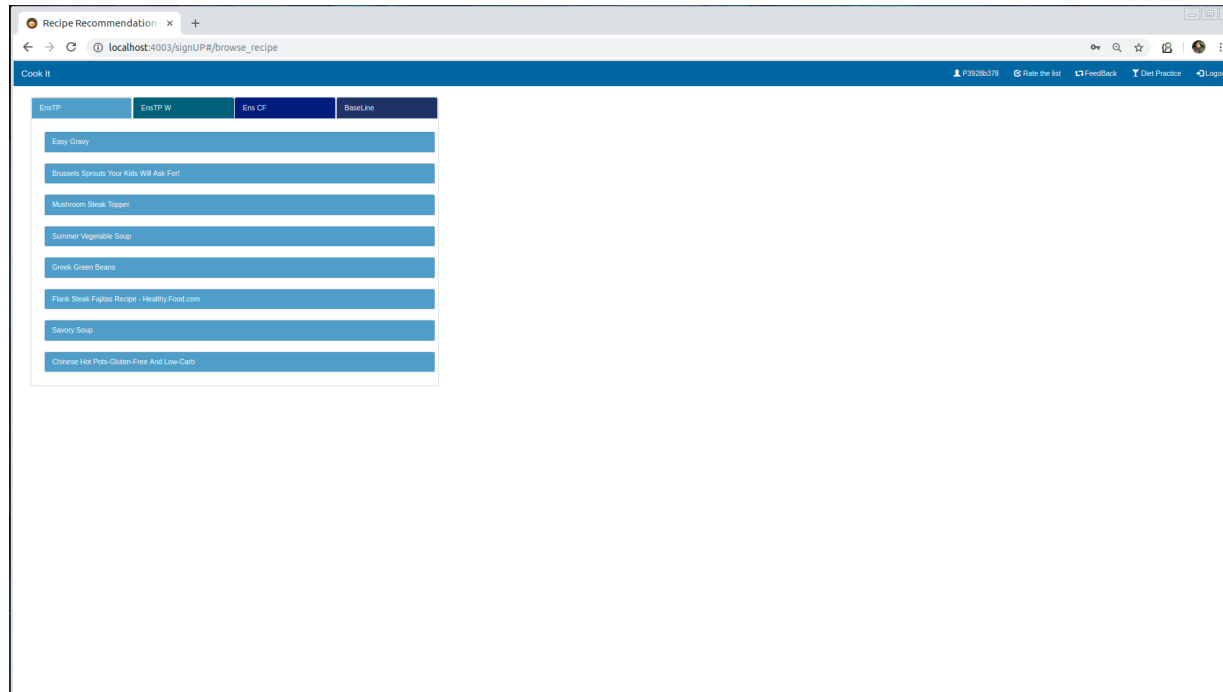
# User Study : 4 recommenders and 48 user



# User Study : 4 recommenders and 48 user



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Recipe Recommendation x +

localhost:4003/signUP#/browse\_recipe

Cook It

EnStP EnStP W EnStP CF BaseLife

Garlic Soup

A Quick And Easy White Cake

Charred Heirloom Tomatoes With Fresh Herbs

Mushroom Vegetable Soup

Brussels Sprouts Soup

Stir-Fried Peppers With Thyme

Ginger Soup

Creamy Cheesy Vegetable Soup

Stir-Fried Peppers With Thyme

★★★★★

20mins 3-4 Serving 6 Nutrition

**Ingredients**

- 1 : 2 tablespoons olive oil
- 2 : 3 medium bell peppers, of any color cut in 1/2 x 1/4 inch strips
- 3 : 1 1/2 teaspoons chopped fresh thyme leaves or 1/2 teaspoon dried thyme
- 4 : salt and pepper, to taste

**Instruction**

- Step 1 : Heat oil in large skillet or small wok over moderately high heat.
- Step 2 : Add peppers and thyme, stirring frequently, until peppers are tender-crisp.
- Step 3 : Add salt and pepper to taste.
- Step 4 : Serve hot, warm or at room temperature.



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The screenshot shows a web browser window with the URL `localhost:4003/signUP#/Rate_D_List`. The page title is "Recipe Recommendation". The main content area contains a rating form with the instruction: "Please rate the following each list in a scale of 0 to 5 based on how much you like the list." Below this instruction is a grid of 48 recipe items, each with a rating bar and a star rating. The recipes are arranged in four columns and twelve rows. The first column has 12 items, the second and third columns have 11 items each, and the fourth column has 10 items. The star ratings are: 4 stars for the first column, 5 stars for the second and third columns, and 4 stars for the fourth column. A "Submit" button is located at the bottom right of the form.

Please rate the following each list in a scale of 0 to 5 based on how much you like the list.			
Easy Gravy	Garlic Soup	Cook Pot - Best Chuck Roast	Lazy Stuffed Cabbage Casserole
Brussels Sprouts Your Kids Will Ask For!	A Quick And Easy White Cake	Red Root Soup	Chicken Cabbage Stir Fry
Mushroom Steak Topper	Charred Heirloom Tomatoes With Fresh Herbs	Easy Chicken Noodle Casserole	Lemon And Oregonio Lamb Chops Recipe - Australian.Food.com
Summer Vegetable Soup	Mushroom Vegetable Soup	Dees Shepherds Pie	Lamb, Artichoke And Tomato Stew
Greek Green Beans	Brussels Sprouts Soup	Brussels Sprouts Your Kids Will Ask For!	Lamb Tagine
Flank Steak Fajitas Recipe - Healthy.Food.com	Stir-Fried Peppers With Thyme	Deluxe Pinto Beans	Argentan Lamb And Lentil Soup
Savory Soup	Ginger Soup	Peking Pork Spare Ribs	Lamb Shank On Cannellini Beans
Chinese Hot Pots: Gluten-Free And Low-Carb	Creamy Cheesy Vegetable Soup	Dirty Rice - Vegetarian Style	Gluten Free Triple Coconut Muffins Delicious And Healthy
★★★★	★★★★★	★★★★★	★★★★

Submit

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The screenshot shows a web browser window with the URL `localhost:4003/signUP#/YourFoodPractice`. The page title is "Recipe Recommendation". The browser's address bar shows the URL and navigation icons. The page content includes a blue header with the text "Cook R" and user information: "P3928/378", "Rate the list", "FeedBack", "Diet Practice", and "Logout".

A blue-bordered box contains the instruction: "Please select your food practice and rate the recommendation lists in a scale of 0 to 5 based on, how much it was addressing your food practice."

The form is divided into two columns:

- Your Food Practice:** A list of radio buttons for selection:
  - Meat Eater
  - Flexitarian
  - Pescatarian
  - VEGETARIAN
  - Pollo Vegetarian
  - Ovo Vegetarian
  - Macrobiotic
  - Vegan
  - No pork + No alcohol
  - No beef
  - Any nutrient restriction
- Description:** Text descriptions for each practice:
  - Meat Eater: eats all kind of meat and dairy products
  - Flexitarian: no red meat
  - Pescatarian: Vegetarian + Fish
  - VEGETARIAN: Vegetables + Egg + Dairy
  - Pollo Vegetarian: Vegetarian + occasionally chicken
  - Ovo Vegetarian: Vegetarian + egg + no dairy
  - Macrobiotic: Vegetarian + seafood - Egg - Dairy
  - Vegan: Vegetarian - Egg - Dairy
  - Islamic Diet: Islamic Diet
  - Diet followed in Hinduasum: Diet followed in Hinduasum
  - Any nutrient restriction: If you the individual is prescribed to take/avoident food item

Below the selection and description, there are four rating questions, each followed by five stars (★★★★★):

- Did the EnSTP Reclists address your food practice ?
- Did the EnSTP\_W Reclists address your food practice ?
- Did the EnSTP\_CF Reclists address your food practice ?
- Did the Baseline Reclists address your food practice ?

A blue "Submit choice" button is located at the bottom center of the form.

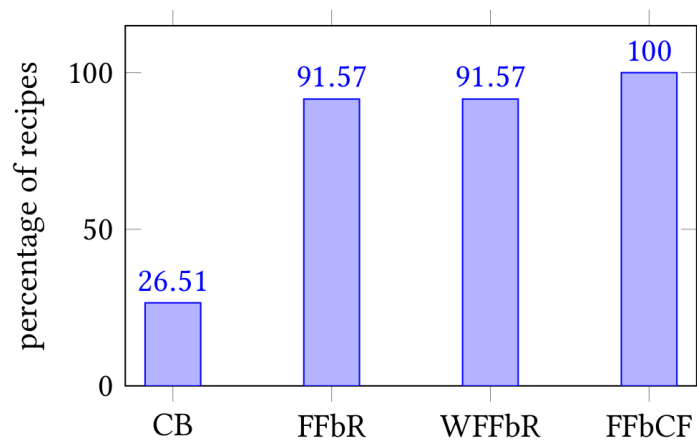
## User Study : 4 recommenders and 48 user

Demo on our developed system could be found on

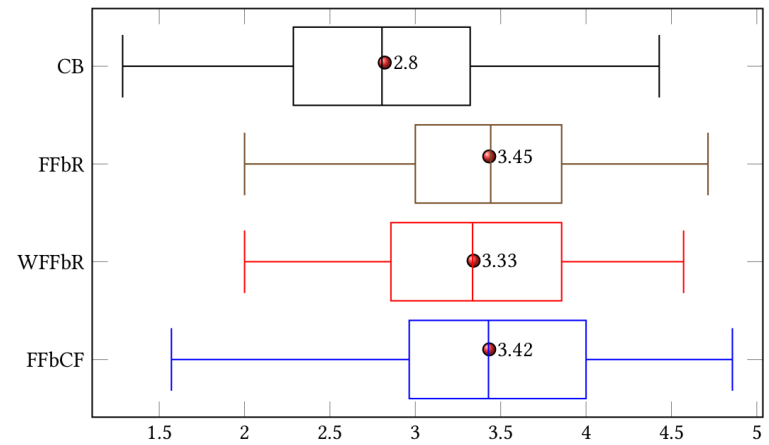
<https://www.youtube.com/watch?v=ujaB0FigRwk>

# Results

## Coverage

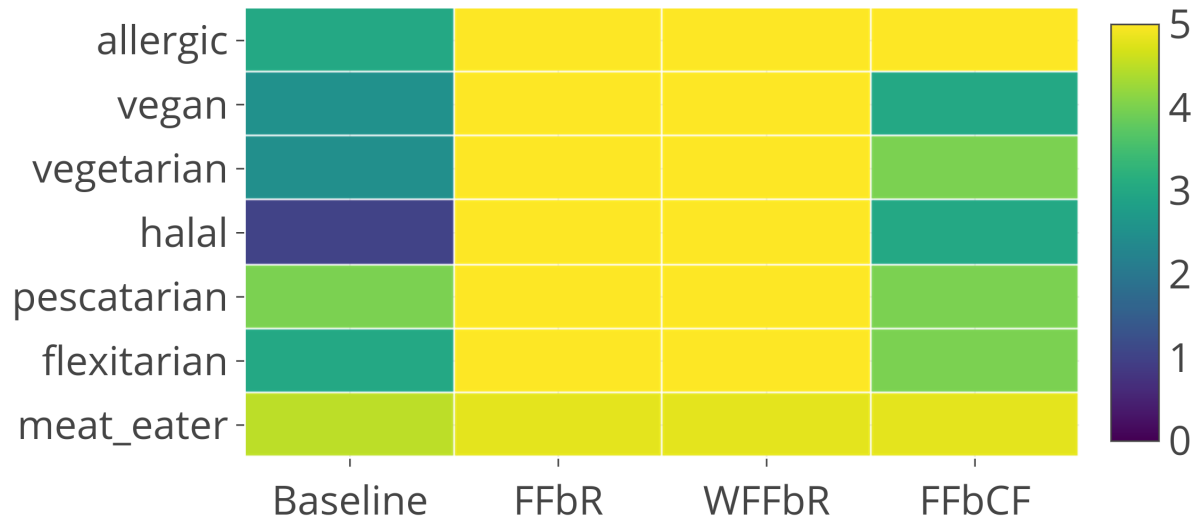


## User preference



# Results

Identifying user's food requirement and restriction



## Recommending Healthy Recipe ??

**Distributions of items(recipes)in my data-set over WHO and FSA Health Scales.**

	<u>Total (percentage)</u>		<u>Total (percentage)</u>	
WHO score	Recipes n =230872	FSA score	Recipes n =230872	
<b>0</b>	88(.04)	<b>4</b>	40877(17.71)	
<b>1</b>	2732(1.18)	<b>5</b>	32227(13.96)	
<b>2</b>	15603(6.76)	<b>6</b>	44807(19.41)	
<b>3</b>	63969(27.71)	<b>7</b>	40647(17.61)	
<b>4</b>	123453(53.47)	<b>8</b>	30754(13.32)	
<b>5</b>	22395(9.7)	<b>9</b>	24249(10.5)	
<b>6</b>	2533(1.1)	<b>10</b>	13002(5.63)	
<b>7</b>	99(0.04)	<b>11</b>	4009(1.74)	
<b>8</b>	0(0)	<b>12</b>	300(0.13)	

## Recommending Healthy Recipe ??

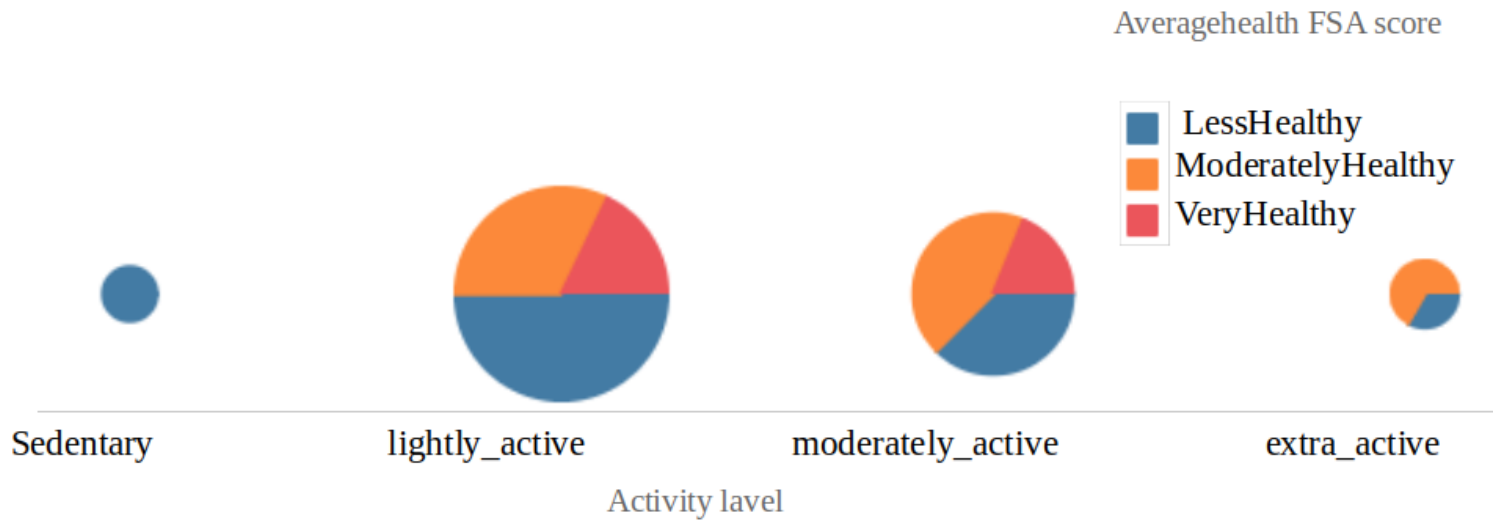
	<b>%</b>	<b>Features</b>
context	4.2	holiday-food, beginner-cook, week-night, inexpensive , 6-people-or-more, potluck
cuisine	6.7	italian, hawaiian, tex-mex, chinese, cajun
equipment	2.4	saucepan, thermomix, wok, dutch-oven
cooking process	3.12	few-steps-recipe, less-than-one-hour, fried, slow-cooked, marinated, 4-hours-or-more
ingredient	61.15	poultry, feta, spaghetti, shredded-mea
category	15.2	risotto, lasagna, stew, appetizer, pot-roast
nutrition	3.01	high-calcium, low-cholesterol, egg-free

## Looking for user group with healthier life style??

Scale	Guideline	User Group
Activity Level	FAO: activity level	sedentary, lightly_active, moderately_active, extra_active
BMI	WHO: BMI	underweight, normal_weight , pre_obesity, obesityclass_1
Food Choices	FSA: nutrient intake guideline	less_healthy, moderately_healthy, very_healthy



# Looking for user group with healthier life style??



Users' spread over different Healthiness scale

# Positively correlated features to healthier user groups

Average Food HealthScore		Activity Level	
Feature	r	Feature	r
peanut-butter	0.447989	wing	0.441152
granola	0.365171	tuna	0.430467
lentil	0.360767	tilapia	0.363502
indian	0.356347	salmon	0.359852
cauliflower	0.352353	hawaiian	0.346401
low-cholesterol	0.350818	canadian	0.322470
maple	0.321131	smoothy	0.314174
vegetable	0.307459	chicken-thighs-legs	0.314059
wheat	0.303326	halibut	0.310990
carrot	0.303052	main-dish	0.303345

# Negatively correlated features to healthier user groups

Average Food HealthScore		Activity Level	
r		r	
roast-beef	-0.564273476	hard-boiled	-0.345550067
lasagna	-0.464811126	chicken-breasts	-0.329366275
sausage	-0.389612531	white-rice	-0.32198579
wing	-0.364559511	rice	-0.32198579
thanksgiving	-0.350745293	ham	-0.289471946
chicken-breast	-0.329366275	pear	-0.292700772

Limitation

Feature work

Centre for  
Data Analytics

# Insight



## Thank You

