Exploring Rich Recipe Information for Cross-Region Food Analysis

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Outline

1. Motivation
2. Framework
3. Experiment
4. Conclusions

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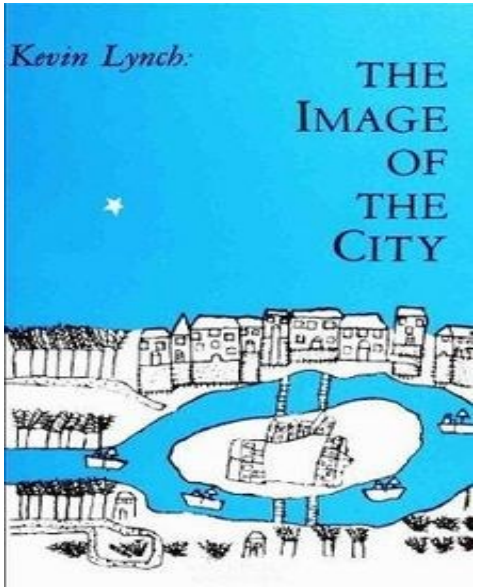
Motivation

In 1960, Kevin Lynch introduced the city's mental map, indicating the city elements that are distinguished among hundreds, thousands, or millions of other city artifacts by their unique shapes, sizes, colors, etc.

- *The Image of the city (1960)*



Motivation

- Each region/country/city has formed a distinct identity, distinguishing itself from other regions

What Makes Paris Look like Paris? [Doersch *et al.* SIGGRPAH2012]

Motivation

- Each region/country/city has formed a distinct identity, distinguishing itself from other regions

Recognizing City Identity via Attribute Analysis of Geo-tagged Images? [Zhou *et al.* ECCV2014]

Architecture

Athletic activity

Social activity

Vegetation

Vertical buildings

Transportation

Water coverage

Motivation

- Each region/country/city has formed a distinct identity, distinguishing itself from other regions

Changing Fashion Cultures? [Abe *et al.* arXiv2017]

Can food make Paris look like Paris?

Motivation

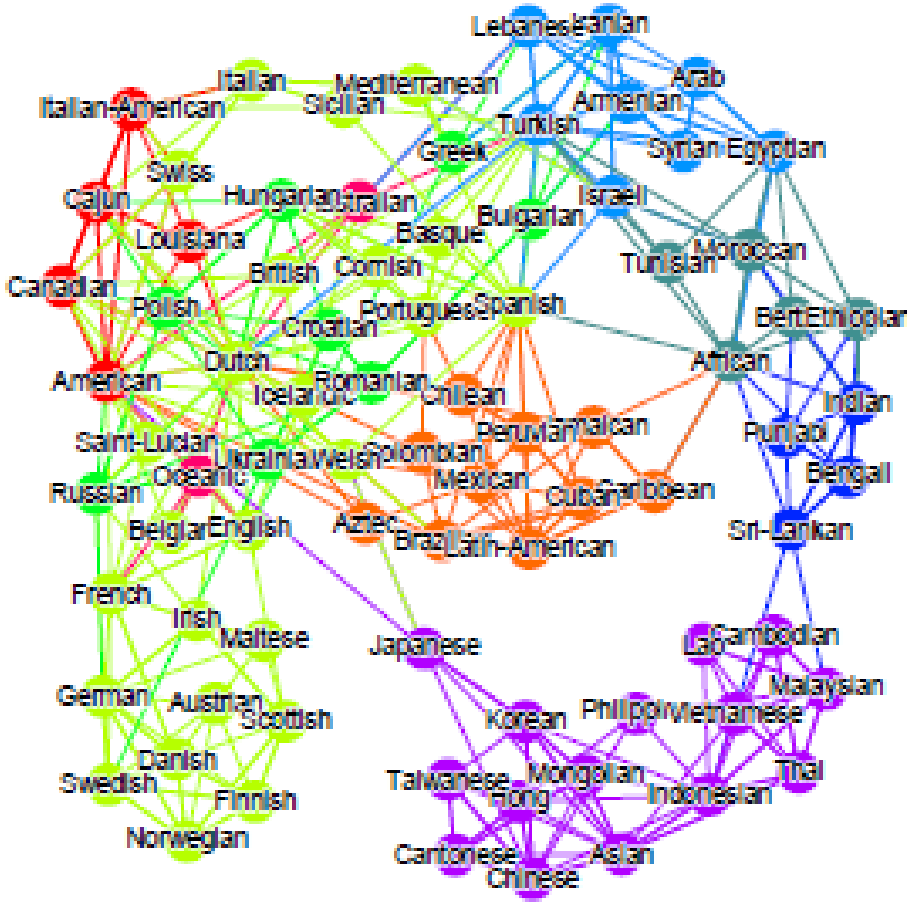
- The variety of regional cuisines

Flavor network and the principles of food pairing [Y.-Y. Ahn,*Scientific Reports*(2011)]

Motivation

- The variety of regional cuisines

Kissing Cuisines [Sajadmanesh, *WWW* (2016)]



Limitation

1. **single-modality (only ingredient)**
2. **Single-dimension**

Motivation

- Food has always been a significant aspect of region identity from different dimensions
  - Food ingredients; Food flavor ; Food visual appearance

Cuisine American

Course Main Dishes

Ingredients chili-powder garlic cinnamon ground-cumin onion-powder pepper flank-steak

Cuisine French

Course Desserts Breakfast and Brunch

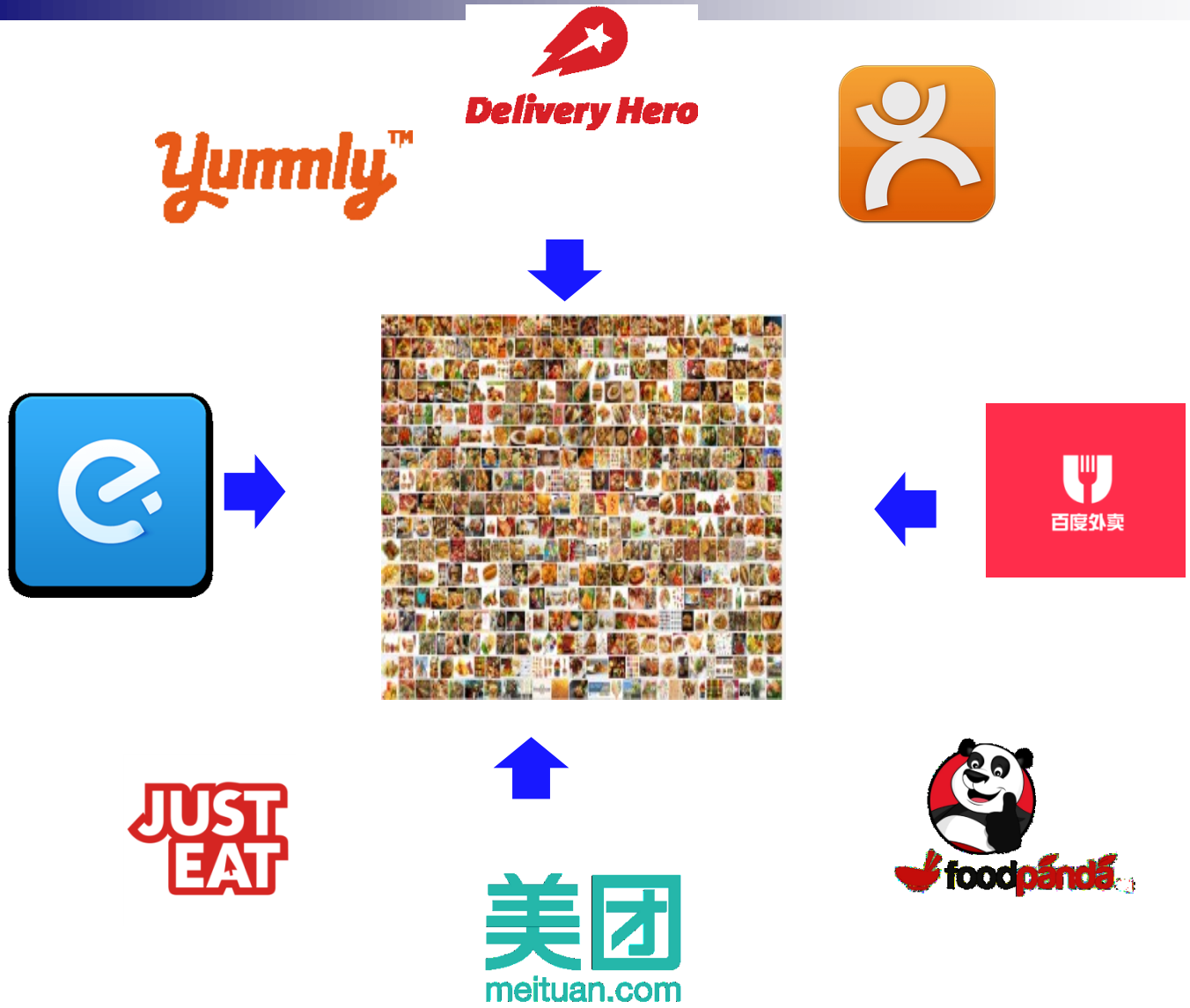
Ingredients bread brown-sugar melted-butter egg milk maple-syrup vanilla-extract sugar ground-cinnamon

Cuisine Chinese

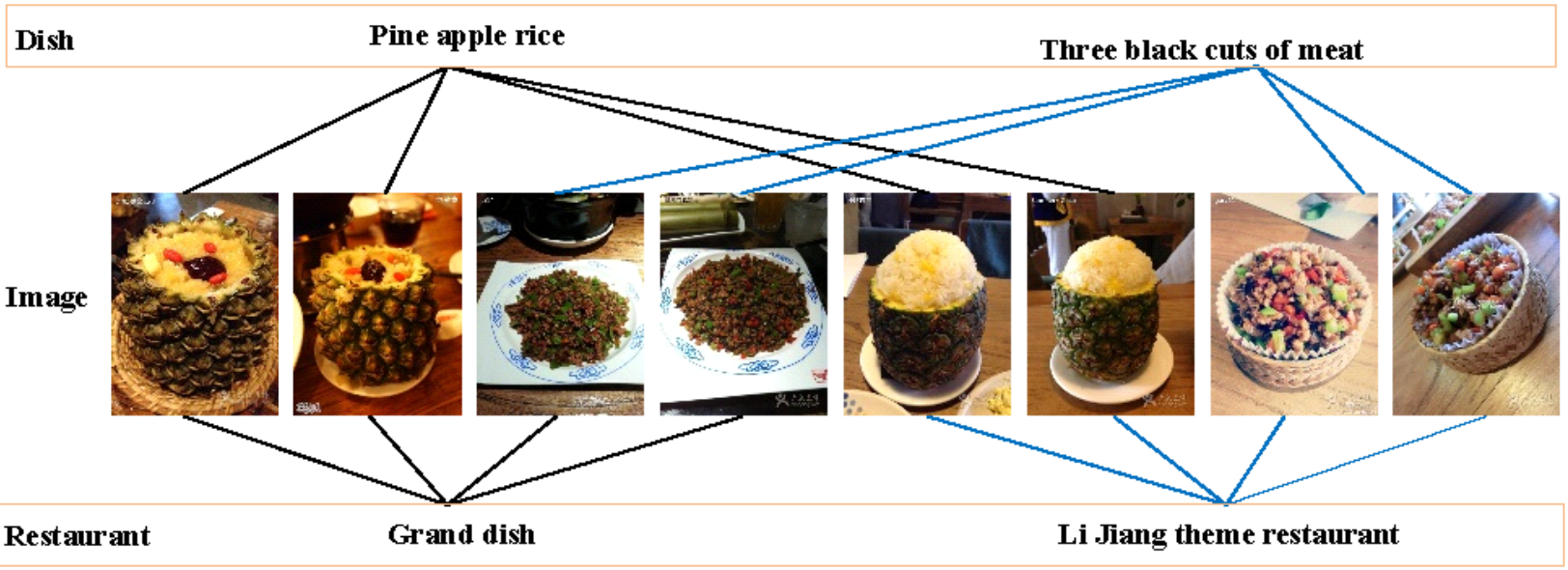
Course Appetizers; Main Dishes

Ingredients medium-shrimp ground-pork bamboo-shoot canola-oil sesame-oil ground-white-pepper wonton-wrapper corn-starch soy-sauce chile-sauce

Motivation


Delivery Hero
Yummly™
百度外卖
JUST EAT
美团
meituan.com
foodpanda

Motivation



Motivation

Yummly™

Photos			
Ingredients	"1 medium onion, chopped fine", "1 teaspoon canola oil", "3 teaspoons sugar", "1 15-oz can tomato sauce", "1 pound boneless, skinless chicken breasts ------	"6 bone-in chicken thighs", "1/2 cup maseca masa flour plus 1/2 cup water", "2 dried ancho chiles, stems removed", "2 medium tomatoes, cut in half", "3 cloves garlic, peeled", "2 chayote squash, or 2 large potatoes", ------	"1 pound mild Italian chicken sausage", "3 carrots", "1 stalk celery", "1 tablespoon extra virgin olive oil", "8 cups chicken broth "1 tablespoon dried Italian seasoning",
Text/Name	Chicken Enchiladas	Ancho Chicken Soup with Masa Dumplings	Hearty Italian Basil Sausage Soup
Cuisine	Mexican	Mexican	Italian
Course	Main Dishes	Soups	Soups


Explore multi-modal multi-attribute recipe information for cross-region food analysis

Motivation

- Applications
  - Facilitate deep understanding of food from the health, marketing and cultural perspectives
  - **Personalized** food preference learning and recommendation
  - Cuisine classification
  - Health diet analysis
  - Mobile food journal
  - ……

Outline

1 ation

2 Framework

3 Experiment

4 Conclusions

Our Framework

Data Input

Yummly

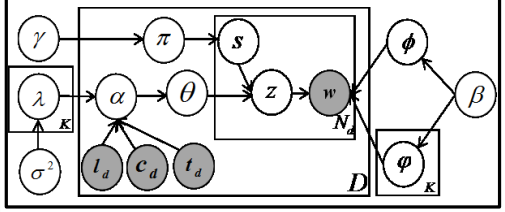
Cuisine American
Course Main Dishes
Flavors
piquant: 0.6667 sour: 0.3333
salty: 0.8333 sweet: 0.1667
bitter: 0.5000 meaty: 0.6667
Ingredients
"1 large onion, diced",
"1 tablespoon olive oil",
"1 large green bell pepper, diced", ...

Cuisine Indian
Course Side Dishes
Flavors
piquant: 0.5 sour: 0.5
salty: 0.8333 sweet: 0.1667
bitter: 0.8333 meaty: 0.1667
Ingredients
"oil", "onions", "green chilies", "cumin seed", "cooked rice", "turmeric", "chili powder", "water", "salt", "cilantro"

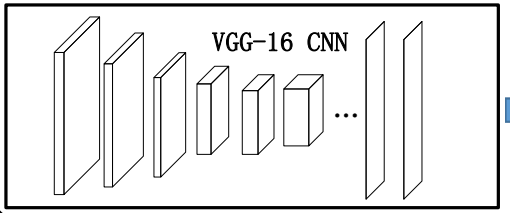
Cuisine Chinese
Course Appetizers, Lunch
Flavors
piquant: 0.1667 sour: 0.1667
salty: 0.1667 sweet: 0.0
bitter: 0.1667 meaty: 0.8333
Ingredients
"chicken wings", "paprika", "crushed red pepper flakes", "ground white pepper", "szechwan peppercorns",

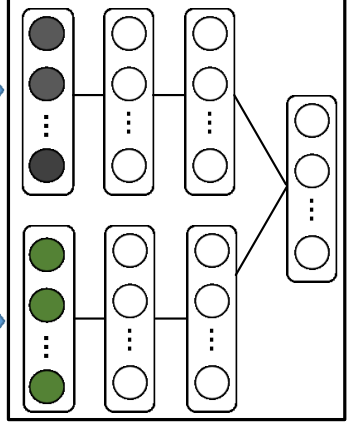
Multi-Attribute Theme Modeling and Multi-Modal Embedding

Multi-Attribute Theme Modeling



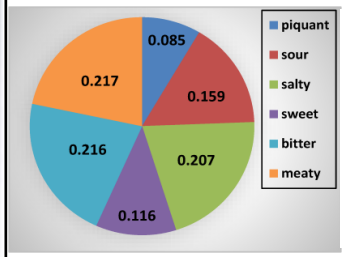
Multi-Model Embedding



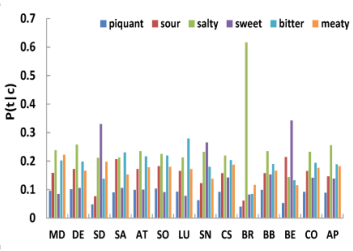


Applications

(1) Flavor analysis and comparison



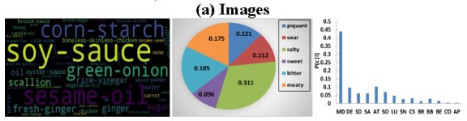
Flavor distribution on American



Flavor distribution on courses

(2) Region-oriented multi-dimensional food summary

(a) Images



(b) Ingredients (c) Flavor distribution (d) Course distribution

(3) Multi-attribute oriented recipe recommendation

Query	Recommendation Results		
Cuisine: French **Course:** Desserts **Flavor:** piquant:0.0 sour:0.17 salty:0.17 sweet:0.83 bitter:0.17 meaty:0.5	 Cherry Chocolate Macarons	 Irish Coffee Creme Brulee	 Peppermint French Macarons
Cuisine: Italian **Course:** Lunch, Breads **Flavor:** piquant:0.17 sour:0.17 salty:0.83 sweet:0.17 bitter:0.17 meaty:0.5	 Pizza Bombs or Pizza Pockets	 Italian Parmesan Pretzels	 Italian Herbs & Cheese Subway Rolls
Cuisine: Chinese **Course:** Breakfast and **Flavor:** Brunch piquant:0.33 sour:0.67 salty:0.83 sweet:0.17 bitter:0.33 meaty:0.83	 Crispy Homemade Takeout Style Veggie Egg Rolls	 Lemon Coke Chicken wings	 Chinese Scallion Pancake

Our Framework

Data Input

Yummly

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Course Main Dishes
Flavors
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Ingredients
"1 large onion, diced",
"1 tablespoon olive oil",
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Course Side Dishes
Flavors
piquant: 0.5 sour: 0.5
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Ingredients
"oil", "onions", "green chilies", "cumin seed", "cooked rice", "turmeric", "chili powder", "water", "salt", "cilantro"

Cuisine Chinese
Course Appetizers, Lunch
Flavors
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Ingredients
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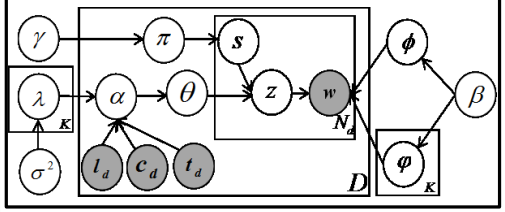
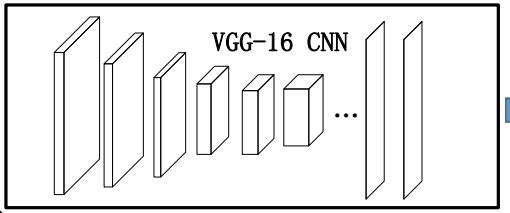
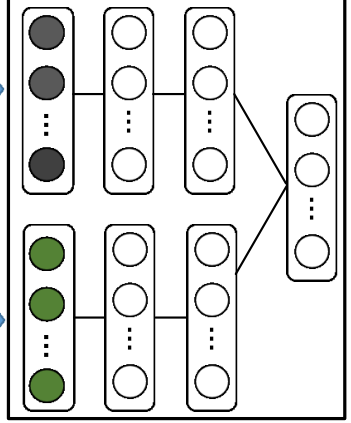
Multi-Attribute Theme Modeling and Multi-Modal Embedding

Multi-Attribute Theme Modeling





Multi-Model Embedding



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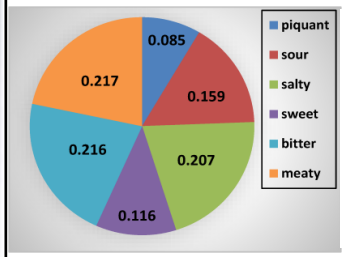

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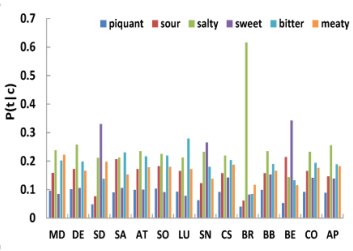

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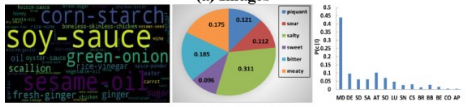

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Yummly™

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Ingredients
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Data Collection

- Data Collection
  - Each recipe: food image, ingredients, course, cuisine(region), flavor

#Items	#Cuisine	#Course	#Flavor	#Ingredients
44,204	10	14	6	2,407

ingredients {0,1} cuisine label {0,1}

course label {0,1} flavor label [0,1]

♯ Type	♯Value
Cuisine	American, Italian, Mexican, Indian, French, Thai, Chinese, Spanish, Greek, Japanese
Course	Main Dishes (MD), Desserts (DE), Side Dishes (SD), Salads (SA),Lunch (LU), Snacks (SN), Soups (SO), Afternoon Tea (AT),Condiments and Sauces (CS), Breads (BR), Breakfast and Brunch (BB), Beverages (BE), Cocktails (CO), Appetizers (AP)
Flavor	Piquant, Sour, Salty, Sweet, Bitter, Meaty

Our Framework

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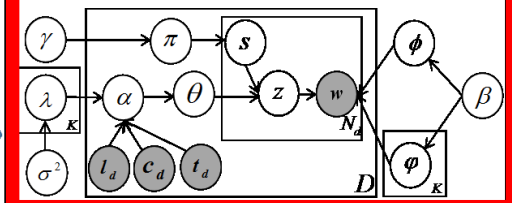

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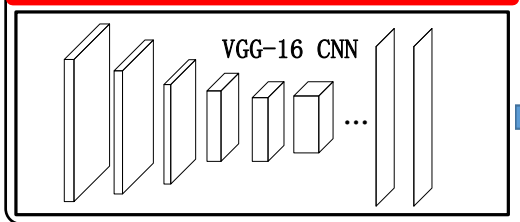

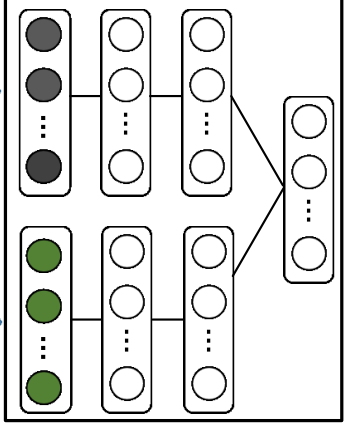

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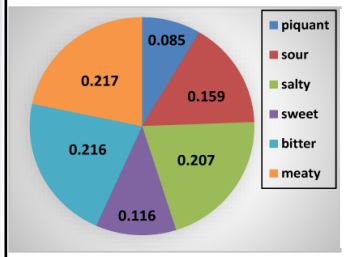

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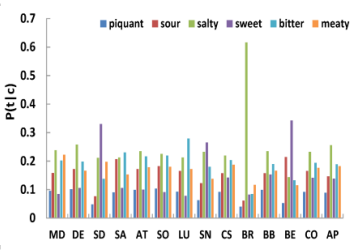

Flavor distribution on courses

(2) Region-oriented multi-dimensional food summary

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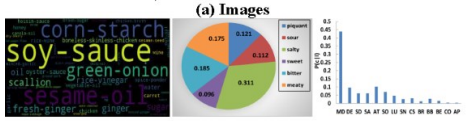

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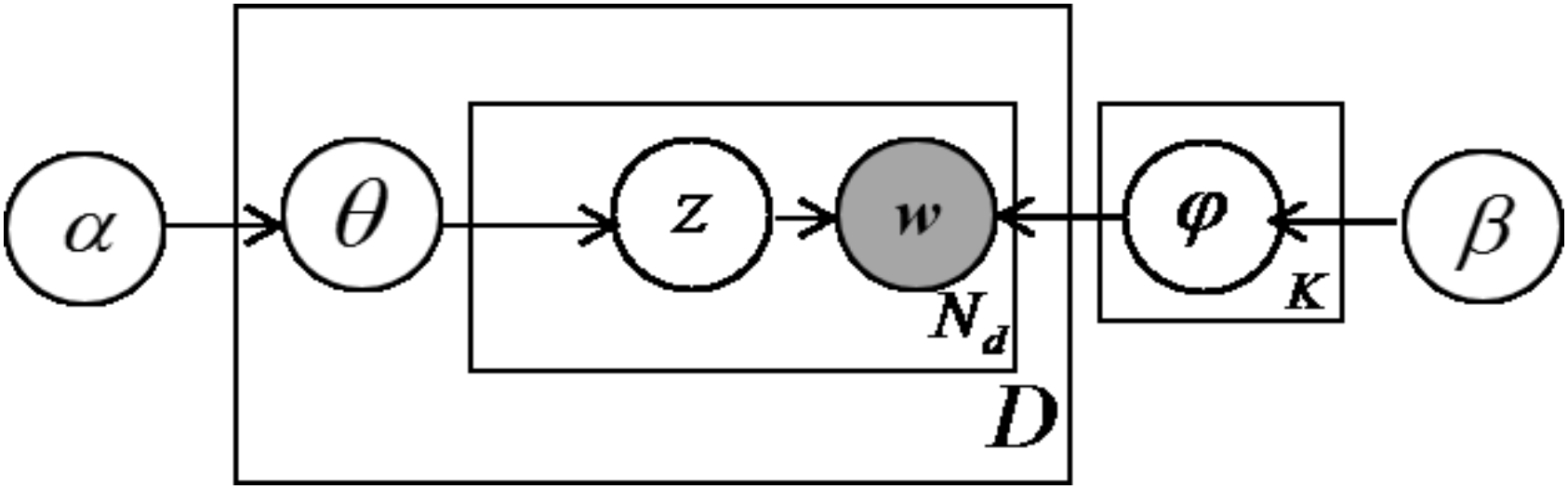
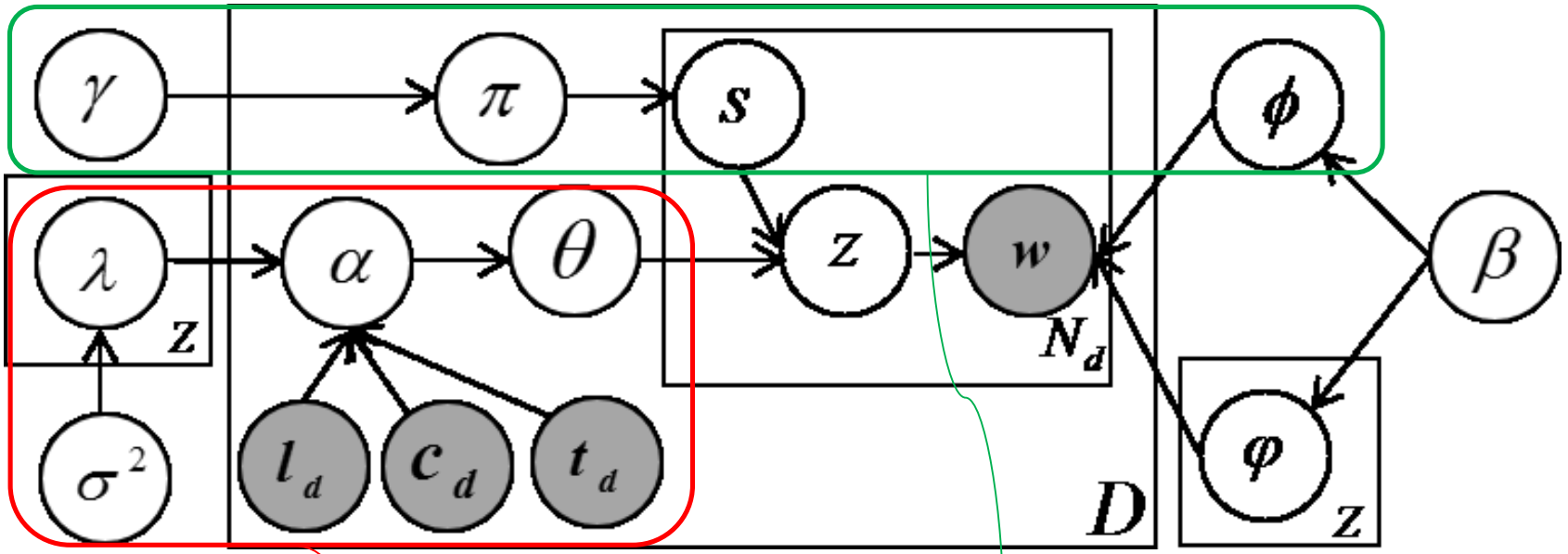
Multi-Attribute Theme Model （MATM)

- Topic models have been proved successfully in discovering meaningful and interpretable topics or patterns in the text domain



Multi-Attribute Theme Model (MATM)



Incorporate attribute with different types

Background distribution

$$\alpha_{dk} = \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k) \quad \mathbf{f}_d = [\mathbf{l}_d; \mathbf{c}_d; \mathbf{t}_d; 1]$$

w: ingredients {0,1} l_d: cuisine label {0,1}

c_d:course label {0,1} td: flavor label [0,1]

Multi-Attribute Theme Model (MATM)

- Generative Process

(1) Draw a background distribution over ingredients $\boldsymbol{\phi} \sim Dir(\boldsymbol{\beta})$

(2) For each theme $k \in \{1, ..., K\}$,
  (a) draw $\boldsymbol{\lambda}_k \sim \mathcal{N}(0, \sigma^2 \mathbf{I})$.
  (b) draw $\boldsymbol{\varphi}_k \sim Dir(\boldsymbol{\beta})$.

(3) For each recipe $d \in \{1, ..., D\}$
  (a) Draw $\boldsymbol{\pi}_d \sim Beta(\boldsymbol{\gamma})$
  (b) for each theme k, let $\alpha_{dk} = \exp(\mathrm{f}_d^T \boldsymbol{\lambda}_k)$
  (c) Draw $\boldsymbol{\theta}_d \sim Dir(\boldsymbol{\alpha}_d)$
  (d) for each ingredient $w_{d,n} \in \mathrm{w}_d$
    (i) Draw a switch variable $s_{d,n} \sim Binomial(\boldsymbol{\pi}_d)$
    (ii) if $s_{d,n} = 0$, draw an ingredient $w_{d,n} \sim Multi(\boldsymbol{\phi}^{bg})$
    (iii) if $s_{d,n} = 1$, draw a theme $z_{d,n} \sim Multi(\boldsymbol{\theta}_d)$, draw an ingredient $w_{d,n} \sim Multi(\boldsymbol{\varphi}_{z_{d,n}})$

Multi-Attribute Theme Model (MATM)

- Model Inference Stochastic EM
  - Stochastic E-Step: sample **z** and **s** given λ

$$p(z_i^m = k, s_i^m = 1 | \mathbf{z}_{\neg i}^m, \mathbf{s}_{\neg i}^m, \mathbf{w}_{\neg i}, w_i = w, \boldsymbol{\alpha}_d^{m-1}, \beta, \gamma) \propto$$

$$\frac{n_{d,1,\neg i} + \gamma}{\sum_s n_{d,s,\neg i} + 2\gamma} \frac{n_{d,k,\neg i} + \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k^{m-1})}{\sum_k (n_{d,k,\neg i} + \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k^{m-1}))} \frac{(n_{k,w,\neg i} + \beta)}{\sum_{w'} n_{k,w',\neg i} + W\beta}$$

$$p(s_i = 0 | \mathbf{z}_{\neg i}^m, \mathbf{s}_{\neg i}^m, \mathbf{w}_{\neg i}, w_i = w, \boldsymbol{\alpha}_d^{m-1}, \beta, \gamma) \propto$$

$$\frac{n_{w_i,\neg i}^{bg} + \beta}{\sum_{w'} n_{w',\neg i}^{bg} + W\beta} \frac{n_{d,0,\neg i} + \gamma}{\sum_s n_{d,s,\neg i} + 2\gamma}$$

  - M-Step : estimate λ given **z** and **s**

$$\frac{\partial \mathcal{L}}{\partial \lambda_{kj}^m} = \sum_{d=1}^{D} \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k^m) \mathbf{f}_{dj} (\Psi(\sum_{k'=1}^{K} \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_{k'}^m)) - \Psi(\sum_{k'=1}^{K} \exp(\mathbf{f}_d^T \boldsymbol{\lambda}_{k'}^m)$$

$$+ n_d^m) + \Psi(\exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k^m) + n_{d,k}^m) - \Psi(\exp(\mathbf{f}_d^T \boldsymbol{\lambda}_k^m))) - \frac{\lambda_{kj}^m}{\sigma^2}$$

L-BFGS

Multi-Attribute Theme Model (MATM)

- Parameter estimation

$$\hat{\pi}_{d,s} = \frac{n_{d,s} + \gamma}{\sum_{s'=0}^{1} n_{d,s'} + 2\gamma} \qquad \hat{\varphi}_{k,w} = \frac{n_{k,w} + \beta}{\sum_{w'=1}^{W} n_{k,w'} + W\beta}$$

$$\hat{\phi}_{w}^{bg} = \frac{n_{w}^{bg} + \beta}{\sum_{w'=1}^{W} n_{w'}^{bg} + W\beta} \qquad \hat{\theta}_{d,k} = \frac{n_{d,k} + \exp(\mathbf{f}_d^T \hat{\boldsymbol{\lambda}}_k)}{\sum_{k=1}^{K}(n_{d,k} + \exp(\mathbf{f}_d^T \hat{\boldsymbol{\lambda}}_k))}$$

The theme distribution for each recipe *d*

$$\hat{\boldsymbol{\theta}}_d = (\hat{\theta}_{d,1}, \ldots, \hat{\theta}_{d,k}, \ldots, \hat{\theta}_{d,K})$$

Our Framework

Data Input

Yummly



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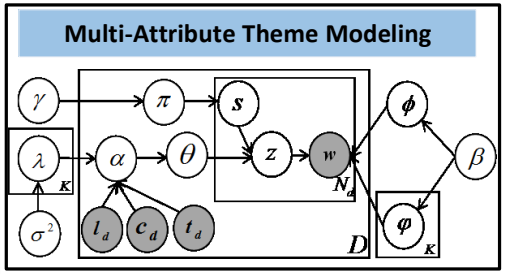
"1 large onion, diced", "1 tablespoon olive oil", "1 large green bell pepper, diced", ...

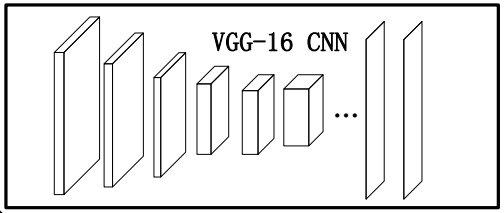
Cuisine Indian
Course Side Dishes
Flavors
piquant: 0.5 sour: 0.5
salty: 0.8333 sweet: 0.1667
bitter: 0.8333 meaty: 0.1667
Ingredients
"oil", "onions", "green chilies", "cumin seed", "cooked rice", "turmeric", "chili powder", "water", "salt", "cilantro"

Cuisine Chinese
Course Appetizers, Lunch
Flavors
piquant: 0.1667 sour: 0.1667
salty: 0.1667 sweet: 0.0
bitter: 0.1667 meaty: 0.8333
Ingredients
"chicken wings", "paprika", "crushed red pepper flakes", "ground white pepper", "szechwan peppercorns",

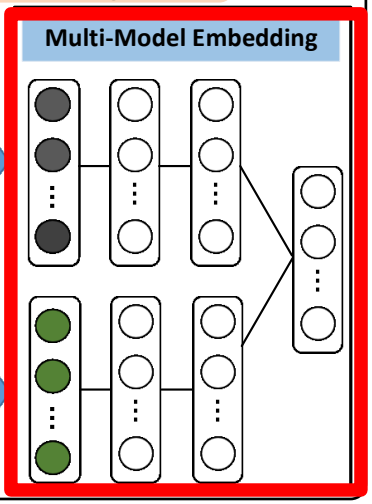
Multi-Attribute Theme Modeling and Multi-Modal Embedding

Multi-Attribute Theme Modeling



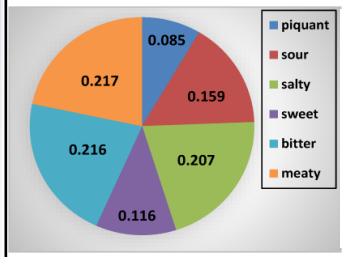


Multi-Model Embedding

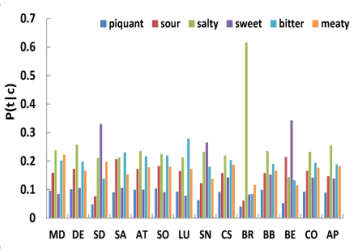


Applications

(1) Flavor analysis and comparison



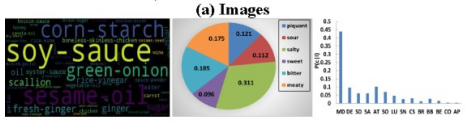
Flavor distribution on American



Flavor distribution on courses

(2) Region-oriented multi-dimensional food summary

(a) Images



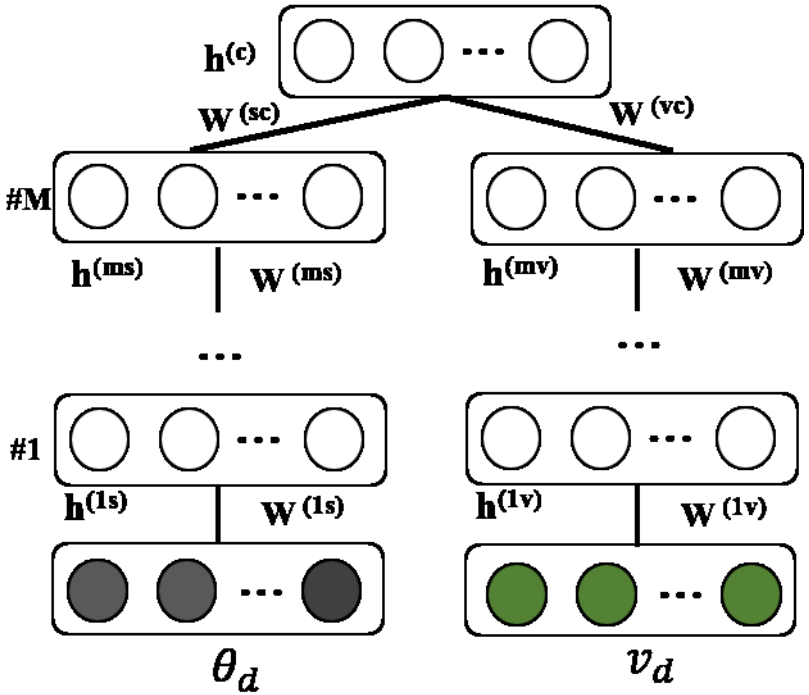
(b) Ingredients (c) Flavor distribution (d) Course distribution

(3) Multi-attribute oriented recipe recommendation

Query	Recommendation Results		
Cuisine: French Course: Desserts Flavor: piquant:0.0 sour:0.17 salty:0.17 sweet:0.83 bitter:0.17 meaty:0.5	 Cherry Chocolate Macarons	 Irish Coffee Creme Brulee	 Peppermint French Macarons
Cuisine: Italian Course: Lunch, Breads Flavor: piquant:0.17 sour:0.17 salty:0.83 sweet:0.17 bitter:0.17 meaty:0.5	 Pizza Bombs or Pizza Pockets	 Italian Parmesan Pretzels	 Italian Herbs & Cheese Subway Rolls
Cuisine: Chinese Course: Breakfast and Flavor: Brunch piquant:0.33 sour:0.67 salty:0.83 sweet:0.17 bitter:0.33 meaty:0.83	 Crispy Homemade Takeout Style Veggie Egg Rolls	 Lemon Coke Chicken wings	 Chinese Scallion Pancake

Multi-Model Embedding （MME）

- Multi-modal DBM



$\hat{\boldsymbol{\theta}}_d = (\hat{\theta}_{d,1}, \ldots, \hat{\theta}_{d,k}, \ldots, \hat{\theta}_{d,K})$	VGG-16 deep features

$$P(\hat{\theta}_{dk} = 1|\mathrm{h}^{(1s)}) = \frac{\exp(b_k + \sum_j W_{kj}^{(1s)} h_j^{(1s)})}{\sum_{k'} \exp(b_{k'} + \sum_j W_{k'j}^{(1s)} h_j^{(1s)})} \quad v_{di} = 1|\mathrm{h}^{(1v)} \sim \mathcal{N}(b_i + \sigma_i \sum_j W_{ij}^{(1v)} h_j^{(1v)}, \sigma_i^2)$$

Our Framework

Data Input

Yummly

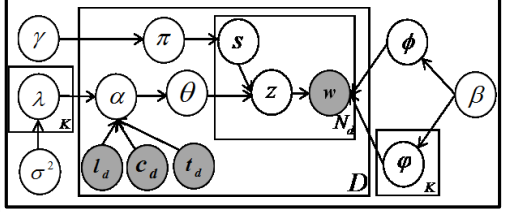
Cuisine American
Course Main Dishes
Flavors
piquant: 0.6667 sour: 0.3333
salty: 0.8333 sweet: 0.1667
bitter: 0.5000 meaty: 0.6667
Ingredients
"1 large onion, diced",
"1 tablespoon olive oil",
"1 large green bell pepper, diced", ...

Cuisine Indian
Course Side Dishes
Flavors
piquant: 0.5 sour: 0.5
salty: 0.8333 sweet: 0.1667
bitter: 0.8333 meaty: 0.1667
Ingredients
"oil", "onions", "green chilies", "cumin seed", "cooked rice", "turmeric", "chili powder", "water", "salt", "cilantro"

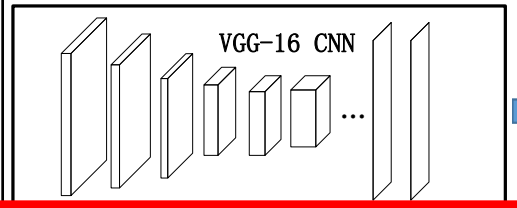
Cuisine Chinese
Course Appetizers, Lunch
Flavors
piquant: 0.1667 sour: 0.1667
salty: 0.1667 sweet: 0.0
bitter: 0.1667 meaty: 0.8333
Ingredients
"chicken wings", "paprika", "crushed red pepper flakes", "ground white pepper", "szechwan peppercorns",

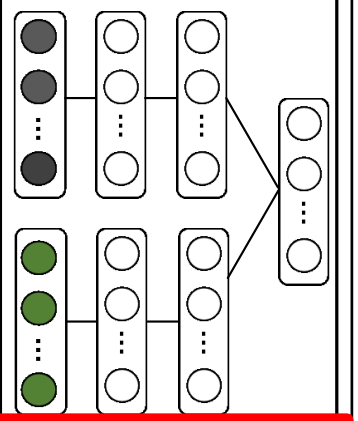
Multi-Attribute Theme Modeling and Multi-Modal Embedding

Multi-Attribute Theme Modeling



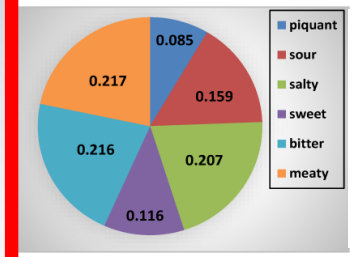
Multi-Model Embedding



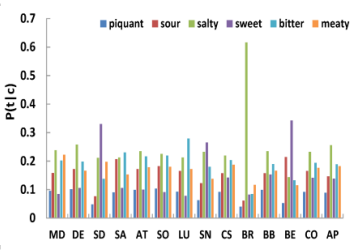


Applications

(1) Flavor analysis and comparison



Flavor distribution on American



Flavor distribution on courses

(2) Region-oriented multi-dimensional food summary

(3) Multi-attribute oriented recipe recommendation

Query	Recommendation Results		
Cuisine: French Course: Desserts Flavor: piquant:0.0 sour:0.17 salty:0.17 sweet:0.83 bitter:0.17 meaty:0.5	 Cherry Chocolate Macarons	 Irish Coffee Creme Brulee	 Peppermint French Macarons
Cuisine: Italian Course: Lunch, Breads Flavor: piquant:0.17 sour:0.17 salty:0.83 sweet:0.17 bitter:0.17 meaty:0.5	 Pizza Bombs or Pizza Pockets	 Italian Parmesan Pretzels	 Italian Herbs & Cheese Subway Rolls
Cuisine: Chinese Course: Breakfast and Flavor: Brunch piquant:0.33 sour:0.67 salty:0.83 sweet:0.17 bitter:0.33 meaty:0.83	 Crispy Homemade Takeout Style Veggie Egg Rolls	 Lemon Coke Chicken wings	 Chinese Scallion Pancake

Applications

1. Cross-Region Flavor Analysis and Comparison

2. Region-Oriented Multi-dimensional Food Summary

3. Multi-Attribute Oriented Recipe Recommendation

Cross-region Flavor Analysis and Comparison

- Flavor distribution on regions

$$p(t|l) = \sum_k \frac{v_{t,k} p(t)}{\sum_{t' \in T} v_{t',k} p(t')} \psi_{l,k}$$

$$p(k|t) = v_{t,k} = \frac{\exp(\mathbf{f}_t^T \hat{\boldsymbol{\lambda}}_k)}{\sum_{k'} \exp(\mathbf{f}_t^T \hat{\boldsymbol{\lambda}}_{k'})} \qquad p(k|l) = \psi_{l,k} = \frac{\exp(\mathbf{f}_l^T \hat{\boldsymbol{\lambda}}_k)}{\sum_{k'} \exp(\mathbf{f}_l^T \hat{\boldsymbol{\lambda}}_{k'})}$$

Region-Oriented Multi-dimensional Food Summary

- Representative ingredients

$$Rep_{l_q}(w) = n(l_q, w)\frac{\sum_k \hat{\varphi}_{kw}\psi_{l_q,k}}{\sum_k \hat{\varphi}_{kw}\psi_{l_q,k} + \hat{\phi}_w^{bg}}, p(w|l_q) = \frac{Rep_{l_q}(w)}{\sum_{w'} Rep_{l_q}(w')}$$

- Representative images

$$sim(l_q, I_d) = \tau\frac{\boldsymbol{\psi}_{l_q}^T \hat{\boldsymbol{\theta}}_d}{\|\boldsymbol{\psi}_{l_q}\|\|\hat{\boldsymbol{\theta}}_d\|} + (1-\tau)\frac{\mathbf{v}_{l_q}^T \mathbf{v}_d}{\|\mathbf{v}_{l_q}\|\|\mathbf{v}_d\|}$$

- Flavor distribution on one region **P(t|l)**

- Course distribution on one region **P(c|l)**

Multi-Attribute based Recipe Recommendation

- Given the multiple query attributes including the cuisine *l* , course *c* and flavor *t* , this task is to recommend relevant recipes to match these query attributes.

$$JsSim(\vartheta_{\mathrm{f}}, \theta_d) = \exp\{-D_{js}(\vartheta_{\mathrm{f}} || \theta_d)\}$$

$$p(k|\mathrm{f}_q) = \frac{\exp(\mathrm{f}_q^T \hat{\lambda}_k)}{\sum_k \exp(\mathrm{f}_q^T \hat{\lambda}_k)} \qquad \mathcal{L}(\mathrm{w}_d) = \prod_{i=1}^{N_d} [\pi_{d,0} \hat{\phi}_{w_i} + \pi_{d,1} \sum_{k \in K} p(k|d) \hat{\phi}_{k,w_i}]$$

Outline

1. Motivation
2. Framework
3. **Experiment**
4. Conclusions

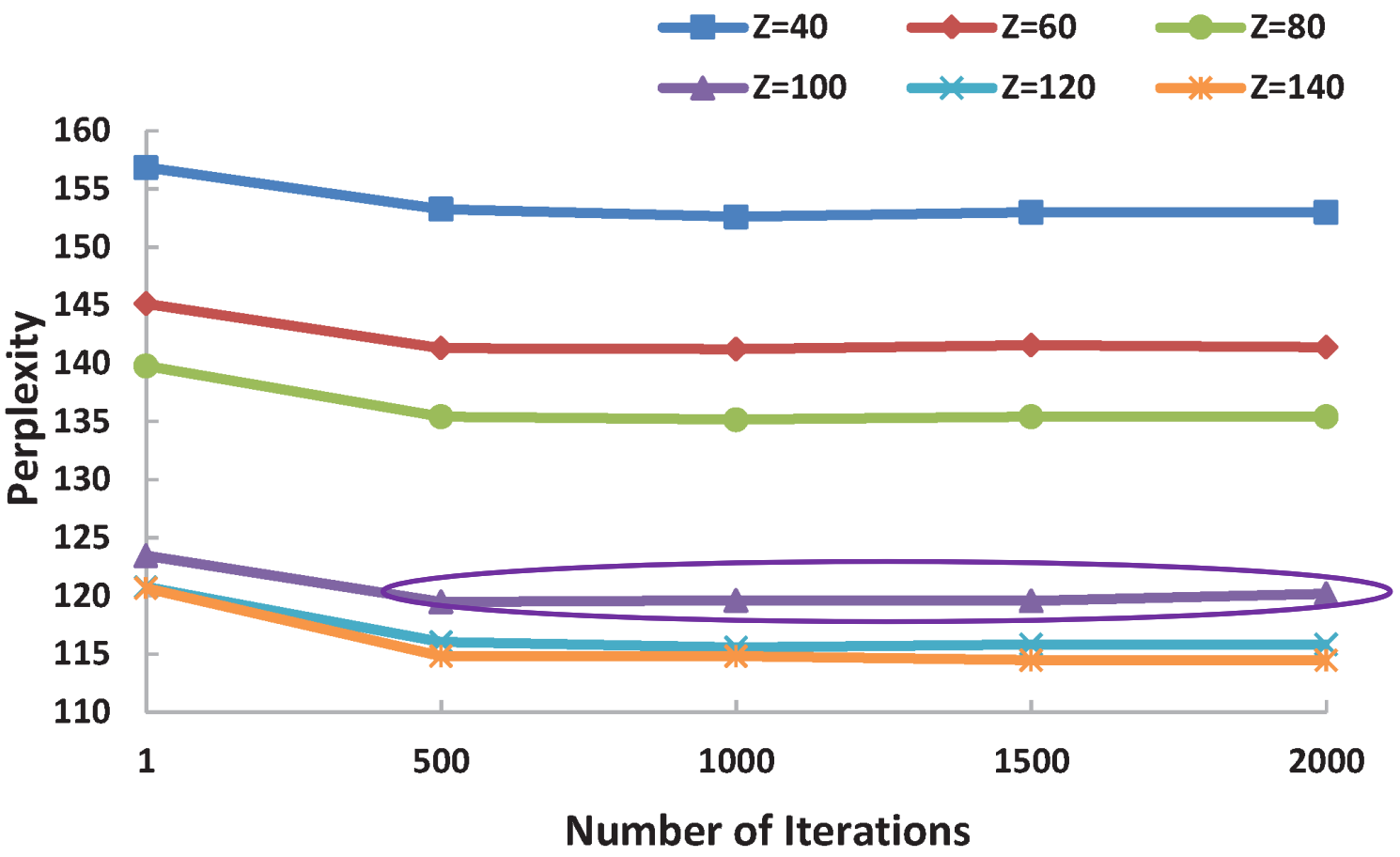
Evaluation of theme model

- Some examples of discovered themes

Theme ♯11	Theme ♯12	Theme ♯44
egg 0.366	honey 0.094	mozzarella-cheese 0.124
milk 0.178	mango 0.073	parmesan-cheese 0.110
salt 0.111	fresh-lime-juice 0.064	ricotta-cheese 0.098
butter 0.060	chopped-fresh-mint 0.041	egg 0.079
flour 0.044	fresh-mint 0.041	lasagna-noodle 0.058
salted-butter 0.032	juice 0.039	marinara-sauce 0.053
melted-butter 0.016	navel-orange 0.036	pasta-sauce 0.044
egg-white 0.015	pineapple 0.035	italian-seasoning 0.043
bread 0.014	orange 0.029	italian-sausage 0.037
honey 0.012	strawberry 0.027	tomato-sauce 0.030

Evaluation of the theme model

- Perplexity



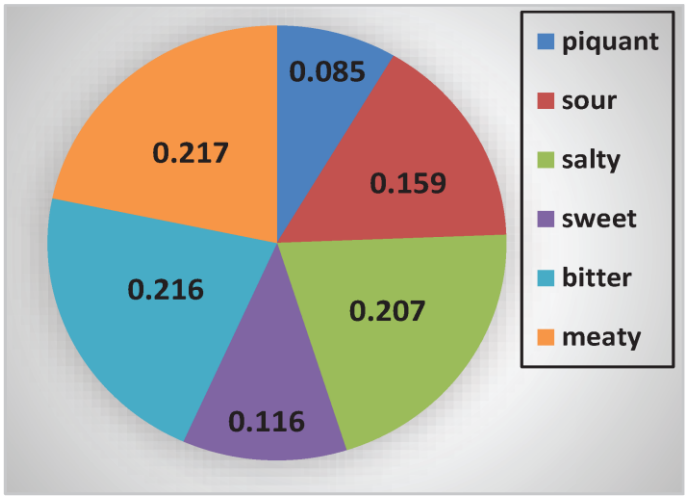
Z = 100

Evaluation of MME

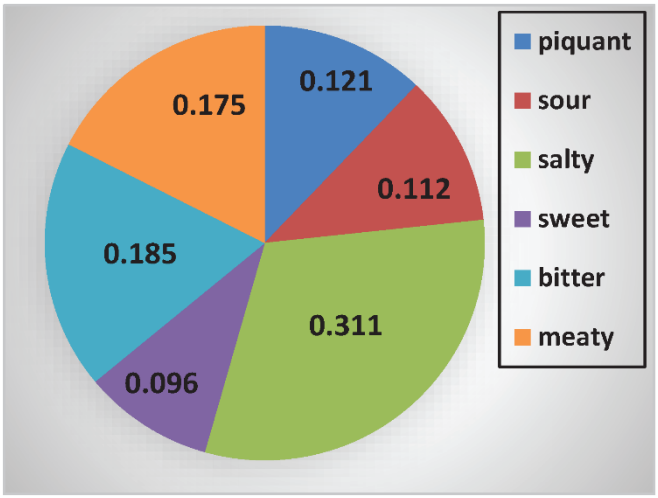
- Top R % : the relative number of images correctly retrieved in the first R% of the ranked list.

Method	R=20	R=40	R=60	R=80
1-layer	0.199	0.399	0.598	0.798
2-layer	0.202	0.399	0.600	0.800
3-layer	**0.207**	**0.411**	**0.615**	**0.810**
4-layer	0.201	0.401	0.600	0.800
5-layer	0.203	0.404	0.603	0.799

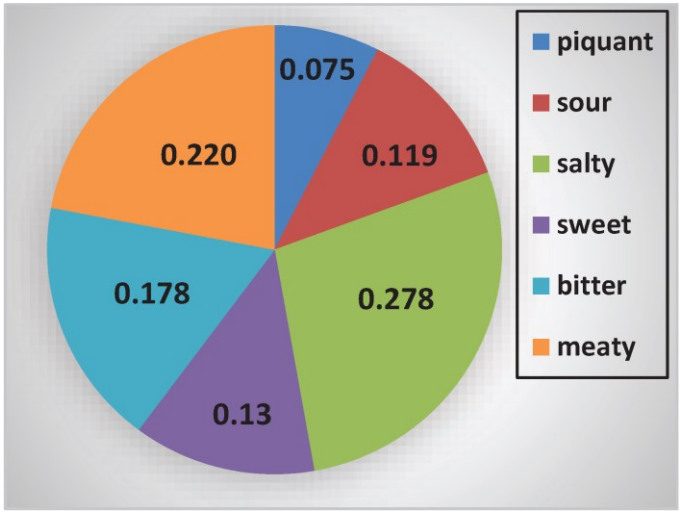
Cross-Region Flavor Analysis



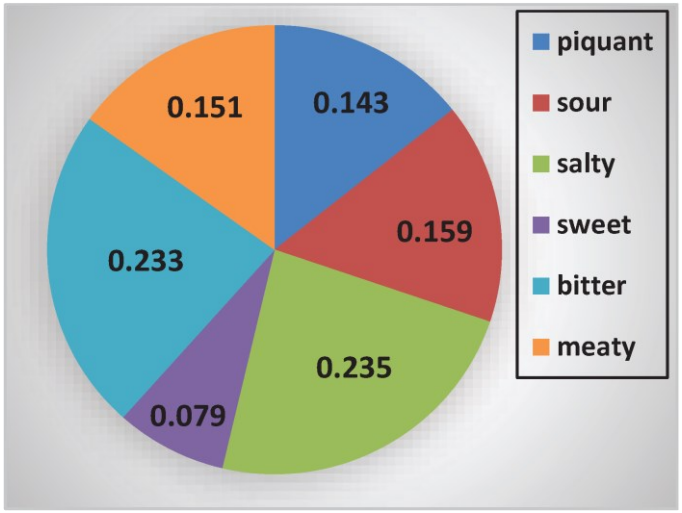
American



Chinese



French



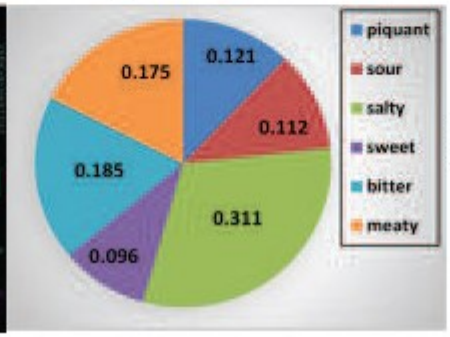
Mexican

Region-Oriented Multi-dimensional Food Summary

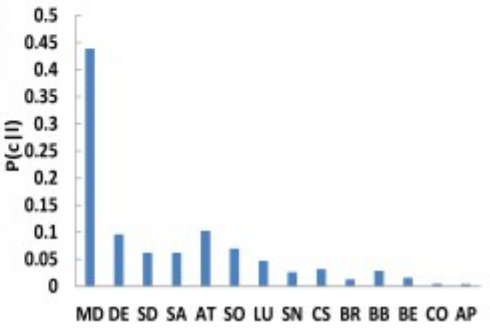
- Chinese Cuisine

(a) Images

(b) Ingredients



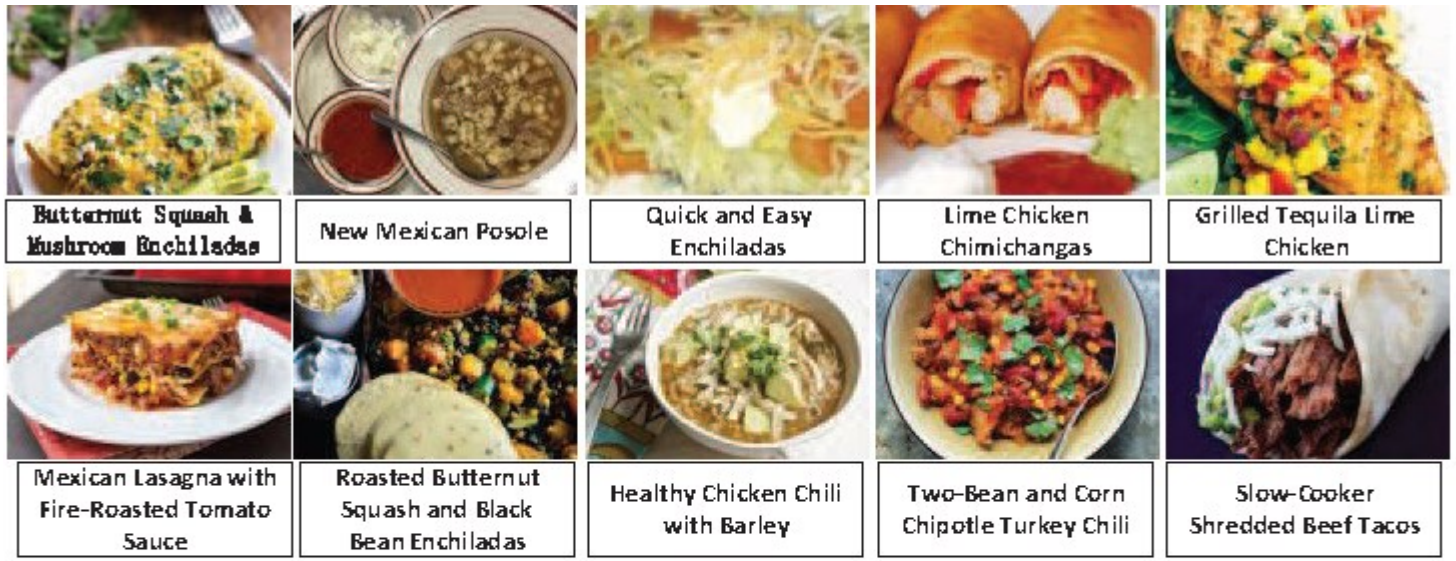
(c) Flavor distribution



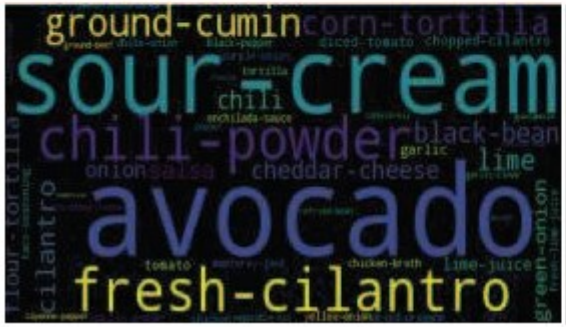
(d) Course distribution

Region-Oriented Multi-dimensional Food Summary

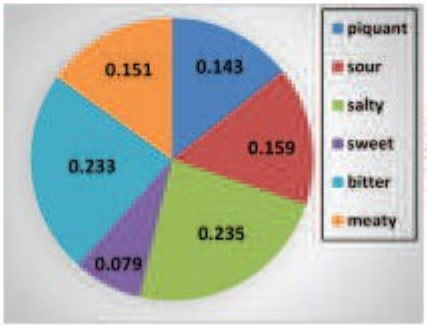
- Mexican Cuisine



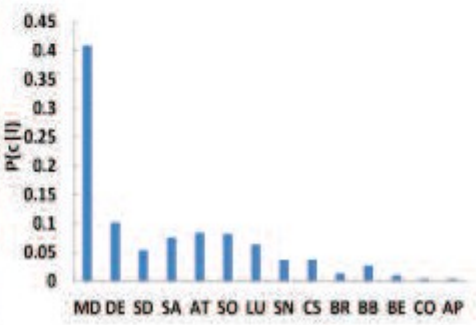
(a) images



(b) ingredients



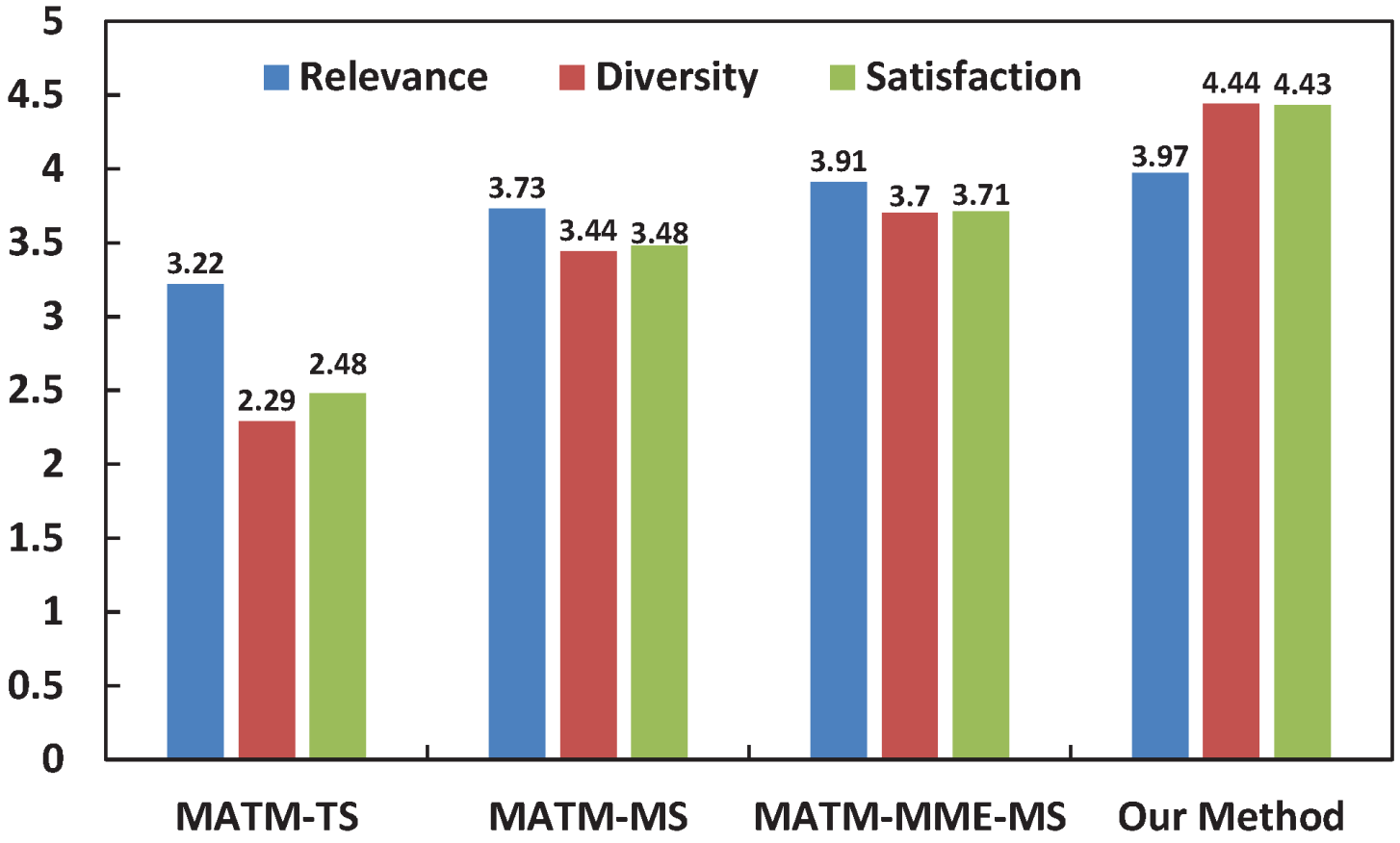
(c) flavor distribution



(d) course distribution

Region-Oriented Multi-dimensional Food Summary

- User study

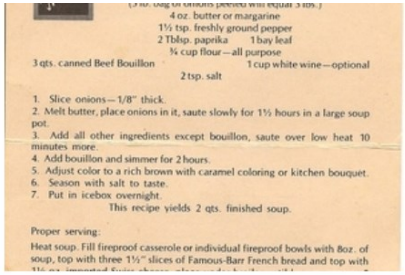


Region-Oriented Multi-dimensional Food Summary

- Why MME?

Ingredients oil chow-mein-noodle sprout yellow-chive white-sesame-seed soy-sauce oyster-sauce sugar sesame-oil soy-sauce wine pepper

Cuisine Chinese


4 oz. butter or margarine
1½ tsp. freshly ground pepper
2 Tbsp. paprika 1 bay leaf
¾ cup flour—all purpose
3 qts. canned Beef Bouillon 1 cup white wine—optional
2 tsp. salt

1. Slice onions—1/8" thick.
2. Melt butter, place onions in it, saute slowly for 1½ hours in a large soup pot.
3. Add all other ingredients except bouillon, saute over low heat 10 minutes more.
4. Add bouillon and simmer for 2 hours.
5. Adjust color to a rich brown with caramel coloring or kitchen bouquet.
6. Season with salt to taste.
7. Put in icebox overnight.

This recipe yields 2 qts. finished soup.

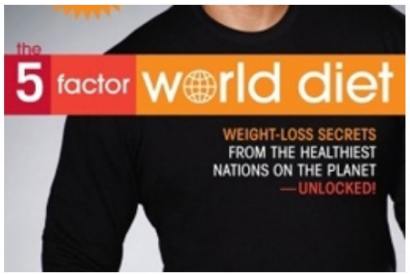
Proper serving:
Heat soup. Fill fireproof casserole or individual fireproof bowls with 8oz. of soup, top with three 1½" slices of Famous-Barr French bread and top with

Ingredients onion salted-butter paprika black-pepper salt flour stock white-wine bay-leaf crust swiss-cheese

Cuisine French

Ingredients pork-shoulder rib salt sugar hoisin-sauce honey soy-sauce sherry oyster-sauce spice-powder orange garlic ginger

Cuisine Chinese

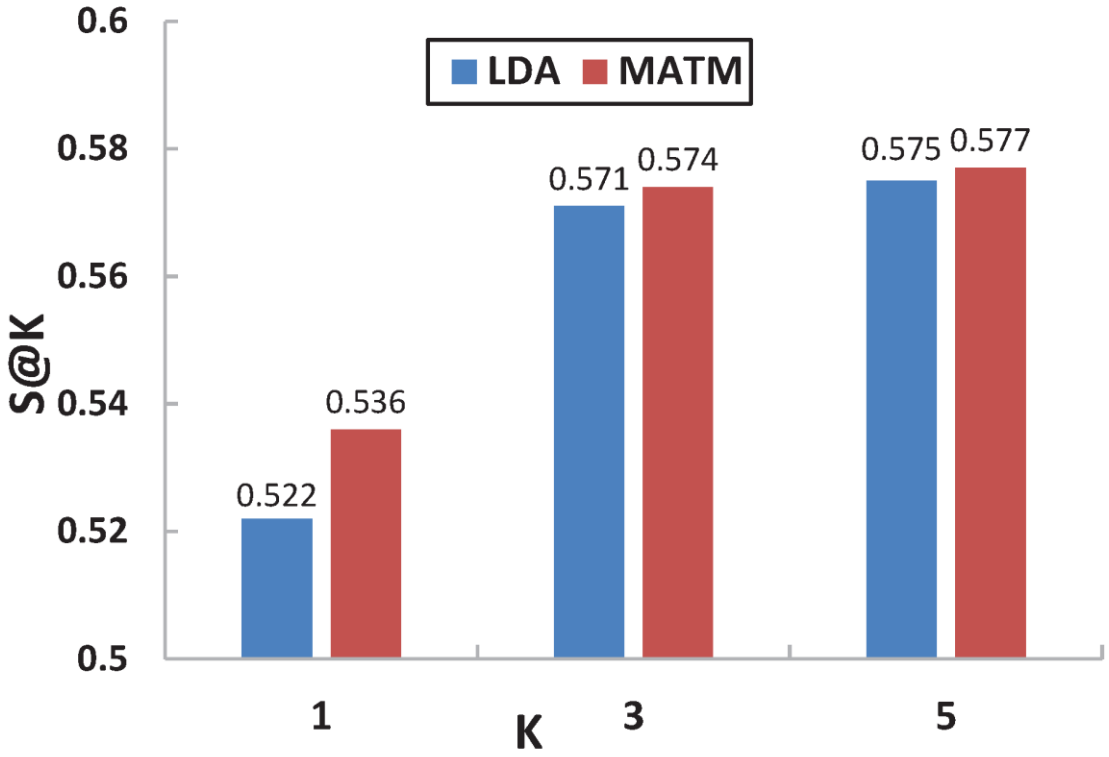


Ingredients olive-oil onion bell-pepper garlic saffron-thread spanish-paprika black-pepper salt chicken-broth arborio-rice large-shrimp pea

Cuisine Spanish

Cuisine Recommendation

- Use the flavor, course and cuisine attributes as the query to retrieve recipes
- Metric: S@H:the success rate of finding the target within the top-H recommendation results



Cuisine Recommendation

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Cuisine: Chinese Course: Breakfast and Flavor: Brunch piquant:0.33 sour:0.67 salty:0.83 sweet:0.17 bitter:0.33 meaty:0.83	 Crispy Homemade Takeout Style Veggie Egg Rolls	 Lemon Coke Chicken wings	 Chinese Scallion Pancake

Outline

1. Motivation
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4. **Conclusions**

Conclusions

- Propose a multi-modal multi-attribute topic modeling and analysis framework, which is capable of exploring rich recipe information for cross-region food analysis.
- The derived attribute-theme representation and multi-modal correlation has demonstrated its effectiveness via our proposed three applications in flavor analysis, food summary and recipe recommendation.
- A multi-modal multi-attribute recipe food dataset is collected and available (**http://isia.ict.ac.cn/dataset**)

Future Work

- Location/region based personalized recommendation
- Product dimension : A food retrieval and recognition system
- Vision based high-level food attribute analysis
- Food calorie estimation
- ……

What other aspects make Paris look like Paris?

Reference

- **Weiqing Min**, Shuqiang Jiang, Jitao Sang, et al. Being a Super Cook: Joint Food Attributes and Multi-Modal Content Modeling for Recipe Retrieval and Exploration. ***IEEE Transactions on Multimedia*** 19(5): 1100-1113 (**2017**)
- **Weiqing Min**, Bing-Kun Bao, Shuhuan Mei, Yaohui Zhu, Yong Rui, Shuqiang Jiang : You Are What You Eat: Exploring Rich Recipe Information for Cross-Region Food Analysis1. ***IEEE Transactions on Multimedia 2017*** **(Accepted)**
- **Weiqing Min**, Shuqiang Jiang, et al. A Delicious Recipe Analysis Framework for Exploring Multi-Modal Recipes with Various Attributes***. ACM Multimedia 2017*** **(Accepted)**

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Thank you!

http://isia.ict.ac.cn/dataset