Geo-Multimedia Analysis and Applications

Weiqing Min
Institute of Computing Technology, Chinese Academy of Sciences
August 24, 2017

Outline

- Introduction
- Two cases
  - Landmark Analysis
  - Cross-Region Food Analysis
- Conclusions

Outline

- Introduction
- Two cases
  - Landmark Analysis
  - Cross-Region Food Analysis
- Conclusions

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Introduction

The fast development of various networks leads to rich multimedia data

Internet

sensor network

mobile network

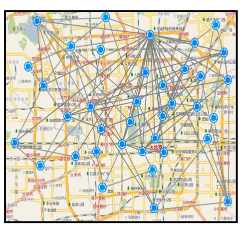
Internet of things

social network

news

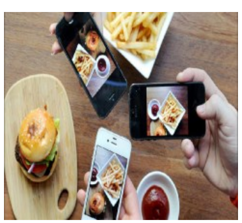
webblog

TV news



user behavior data

surveillance video



images

Introduction

Geo-multimedia data

flickr

YouTube

foursquare

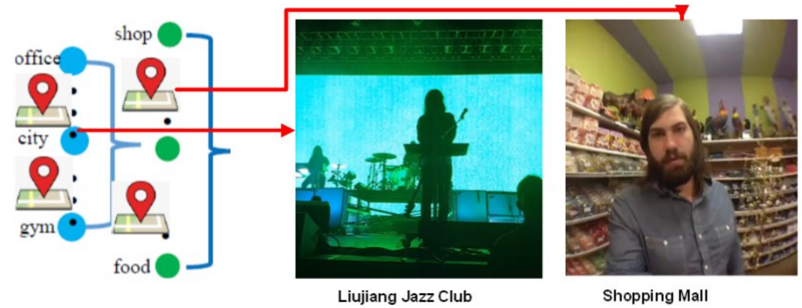
新浪微博

Three characteristics

- Location with different granularities

(51.6174,0.1246)

landmarks: Big Ben



check-in: venues

scene category

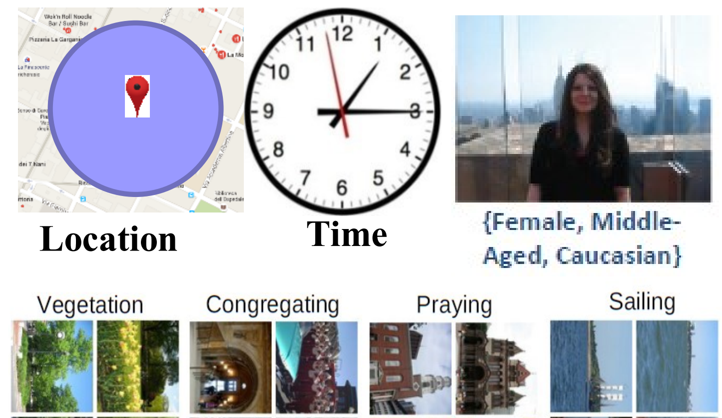
Cuisine American **Course** Main Dishes **Ingredients** chili-powder garlic cinnamon ground-cumin onion-powder pepper flank-steak	**Cuisine** French **Course** Desserts Breakfast and Brunch **Ingredients** bread brown-sugar melted-butter egg milk maple-syrup vanilla-extract sugar ground-cinnamon	**Cuisine** 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

region-level

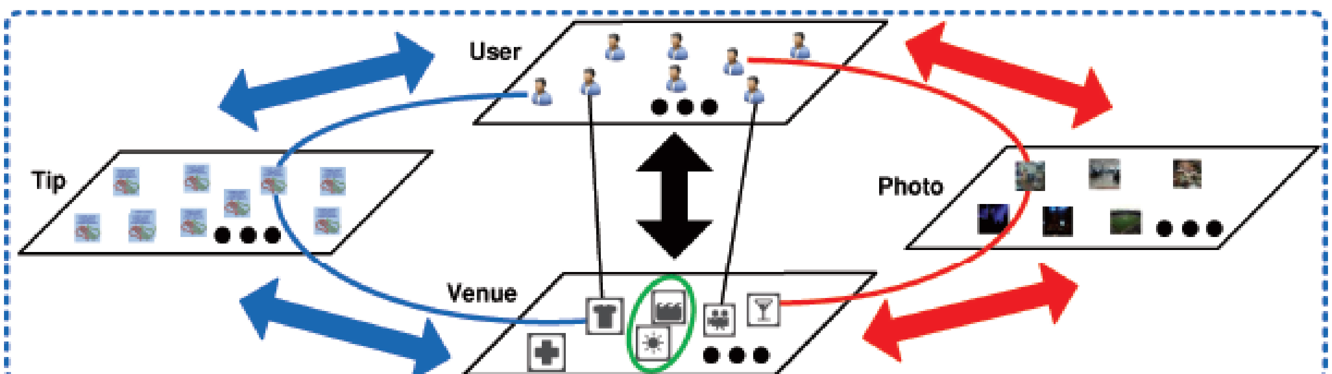
Three characteristics

- multi-modality and heterogeneity

multi-modality



multi-context



multi-interaction

Three characteristics

- Big Geo-Multimedia Data

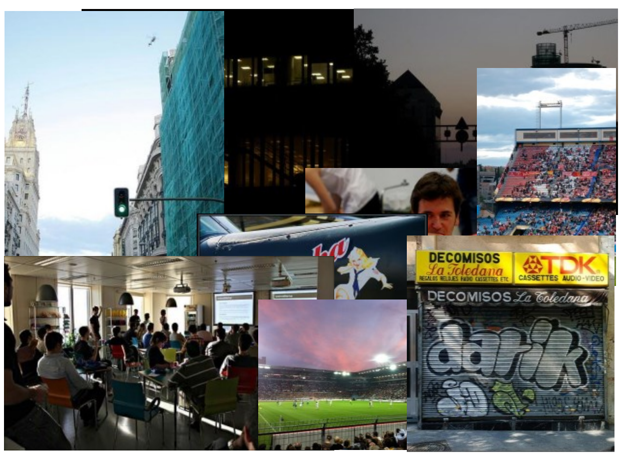
中科院计算所

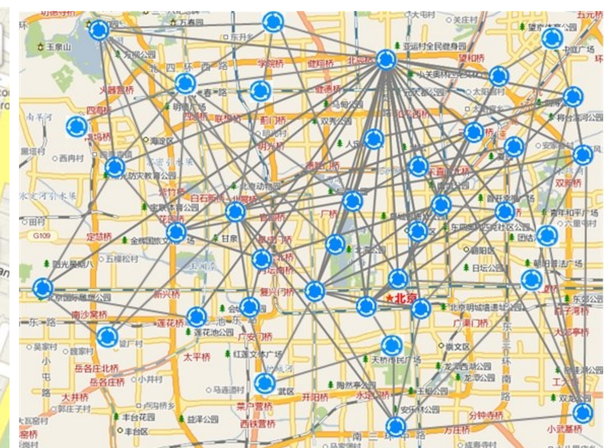
Institute of Computing Technology, Chinese Academy of Sciences

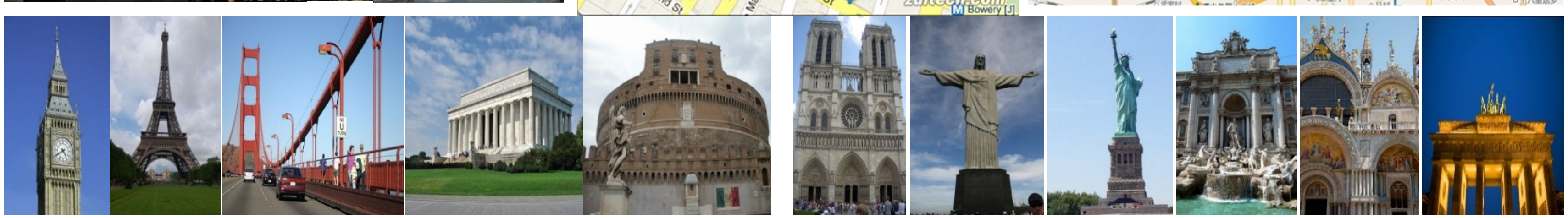
Such rich Geo-Multimedia Big data holds great potentials but also encompass challenges

Opportunities

- Big geo-multimedia data treasure
  - Travel data, including landmarks, GPS trajectories
  - Check-in data, different venues
  - Event data, hot event data







Opportunities

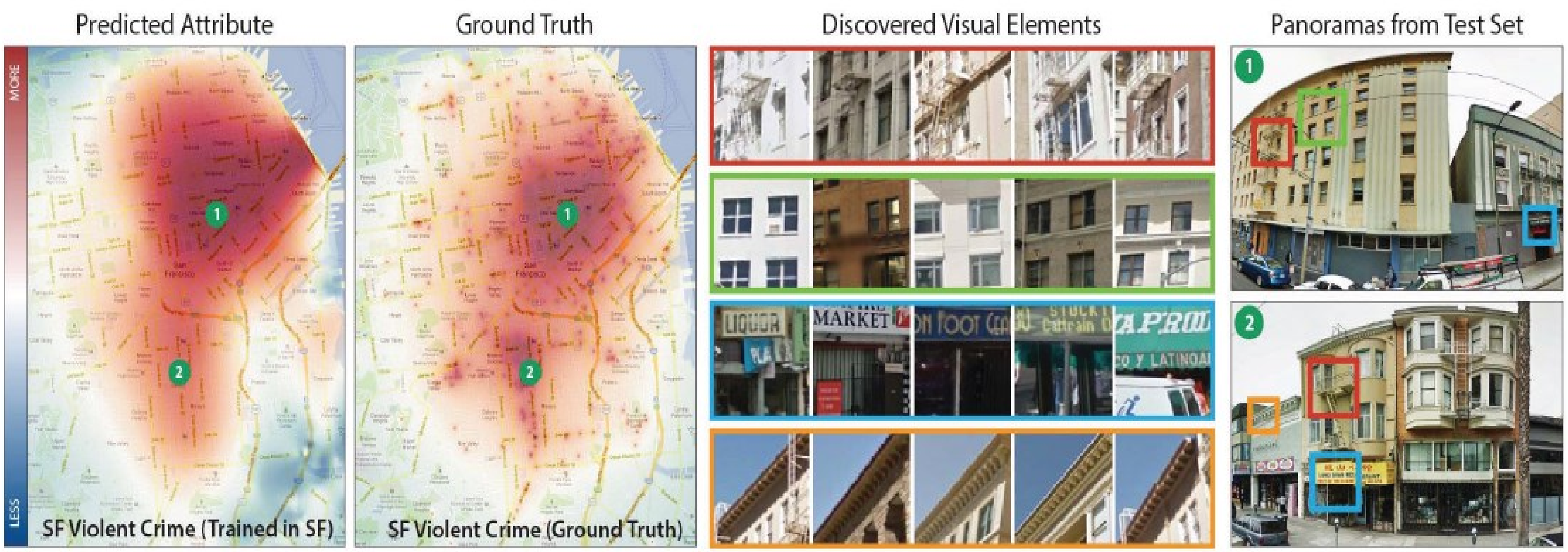
- geo-multimedia computer vision
  - Geo-Multimedia high-level attribute learning

Abhimanyu Dubey, Nikhil Naik, Devi Parikh, Ramesh Raskar, and Csar A. Hidalgo. Deep Learning the City: Quantifying Urban Perception at a Global Scale. **ECCV 2016.**

Opportunities

- geo-multimedia computer vision

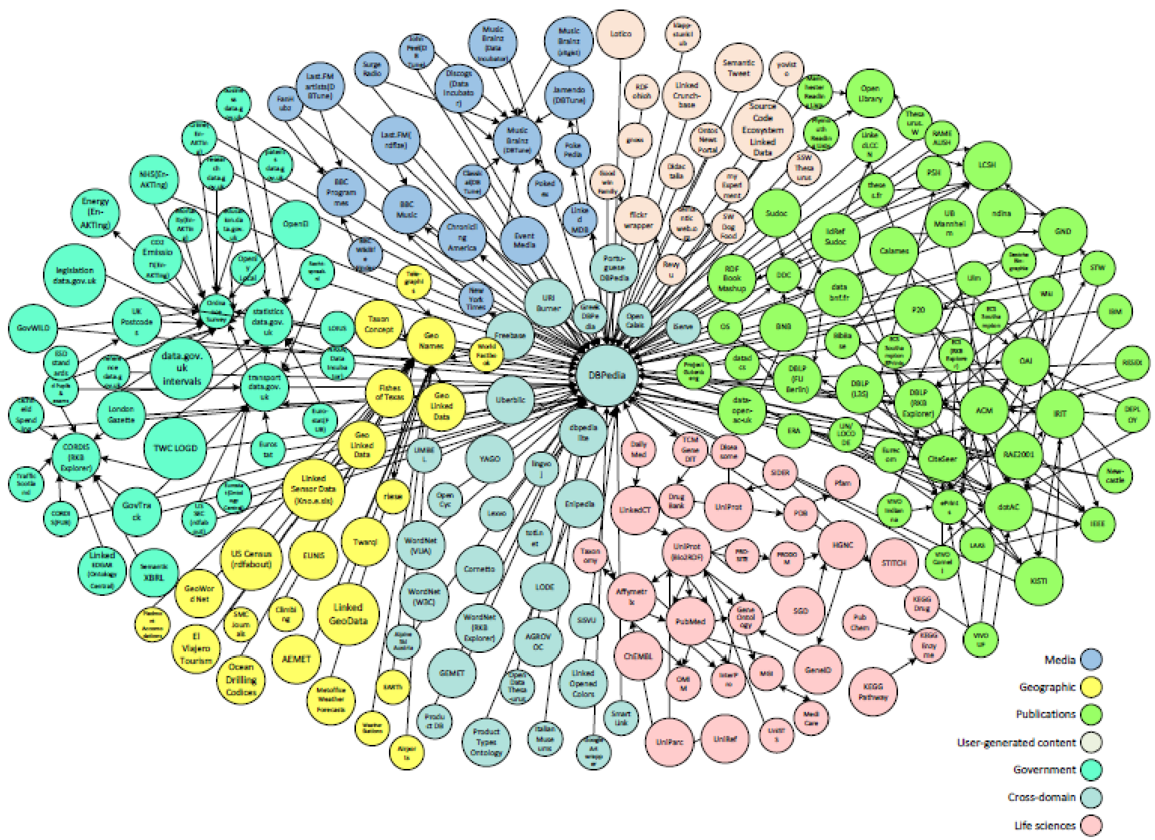
  relationship prediction between visual elements and a number of city attributes e.g. violent crime rates



S. M Arietta, A. A Efros, R Ramamoorthi, and M Agrawala. City forensics: Using visual elements to predict non-visual city attributes. Visualization and Computer Graphics IEEE Transactions on, 20(12):2624–2633, 2014.

Opportunities

- geo-multimedia knowledge graph construction and learning



Yu-xin Peng et al. Cross-media analysis and reasoning: advances and directions. Front Inform Technol Electron Eng. 2017

Opportunities

- Various applications in different fields
  - Region oriented food culture analysis
  - Region oriented user behavior analysis
  - Location based retrieval and recommendation
  - User profile
  - Other location based services
  - ……

Challenges

- Effectively manage geo-multimedia big data, from access, store to retrieval
- Overcome the noisy content and location ambiguity
- Overcome the semantic gap
- Learn geographical hierarchy visual features
- Large scale geo-multimedia data feature learning (Web Vision)
- ……

Research Problems

- Organizing, summarizing and browsing the geo-multimedia data
- Mining and extracting the knowledge from the geo-multimedia data
- Predicting geographic location and other high-level attributes from photos/videos
- Exploring various applications, especially in vertical fields

Outline

- Introduction
- Two cases
  - Landmark Analysis
  - Cross-Region Food Analysis
- Conclusions

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Two cases

- Landmark Analysis

- Cross-Region Food Analysis

Two Cases

- **Landmark Analysis**

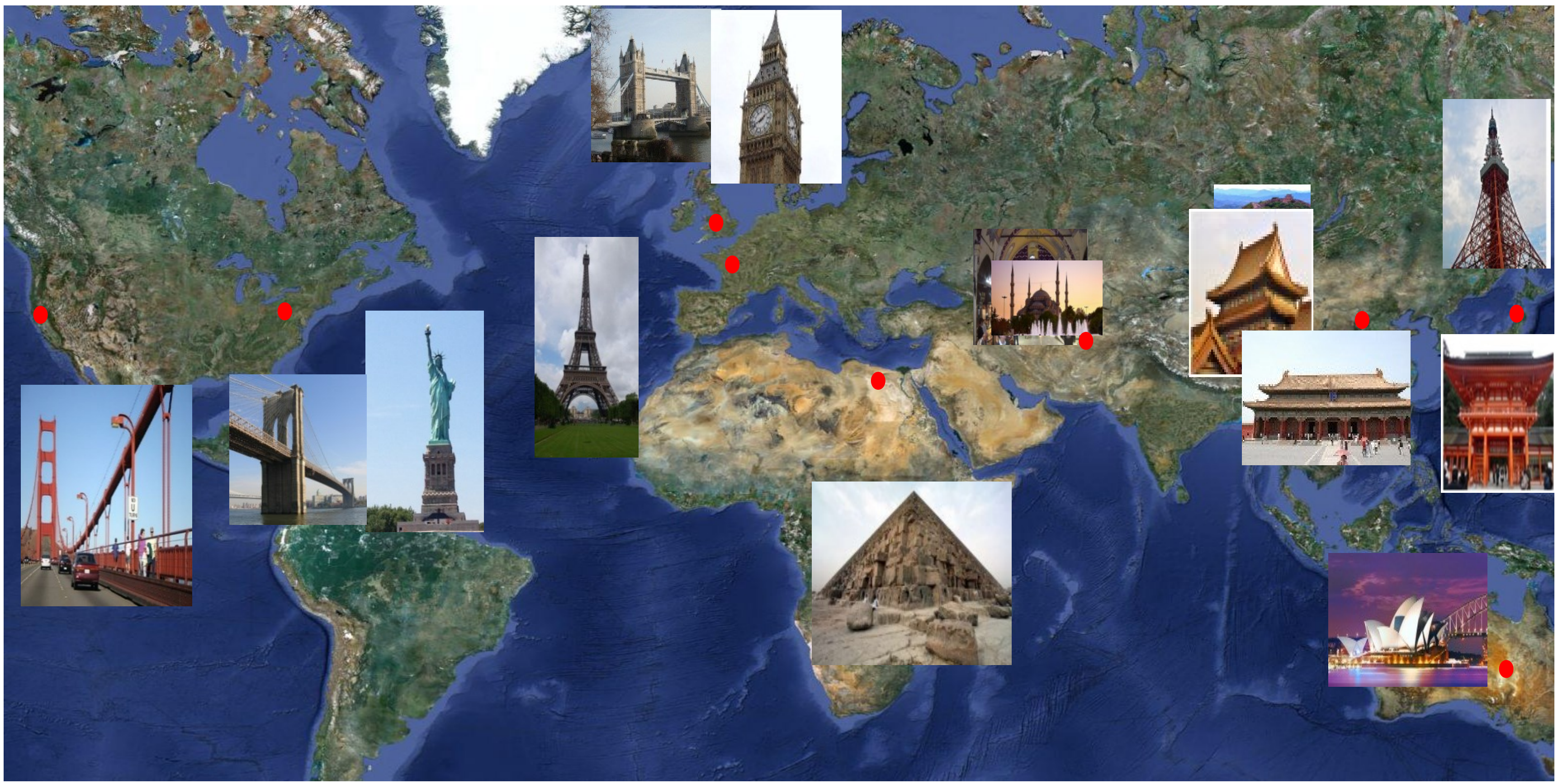



- Cross-Region Food Analysis




Motivation

Landmark: A recognizable place that might be of interest to tourists due to notable physical features or historical significance - Wikipedia



中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences

Motivation

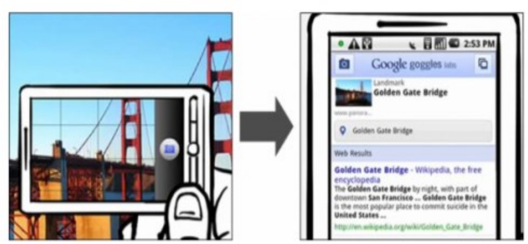
flickr

Picasa

Wikitravel
The Free Travel Guide

YAHOO! TRAVEL

Tour recommendation



Location recognition

Virtual 3D street

Motivation

Relevant Tags:
Japan, gate, Kiyomizu-dera temple, Kyoto Torii, architecture,

Temple

Relevant Tags:
Kiyomizu-der, cherry blossoms, sakura, April

April Sakura

Relevant Tags:
color, autumn leaf, maple, kiyomizu-dera temple, red,

Autumn Maple

Our idea

pictures			
time	2006年8月29日	2008年4月8日	2012年11月21日
tags	Japan August 2006 Kiyomizu-dera Kyoto tour	Japan geotagged Kyoto Higashiyama Kiyomiz dera Gate Sakura Blossoms	autumn color autumn leaf kiyomizu-dera temple kyoto japan maple
title	Kyoto Orange, version 672	Entrance Gate to Kiyomizu-dera	Autumn Color at Kiyomizu-dera tour
Desc.	They have this amazing red-orange all over the shrines/temples in Kyoto.	Kiyomizu-dera, Southern Higashiyama architecture	Panorama of the city center of Kyoto from Kiyomizu-dera (the right hand).

Global theme

Location theme

Time theme

Mining three kinds of themes for landmark analysis

Spatio-Temporal Theme Modeling

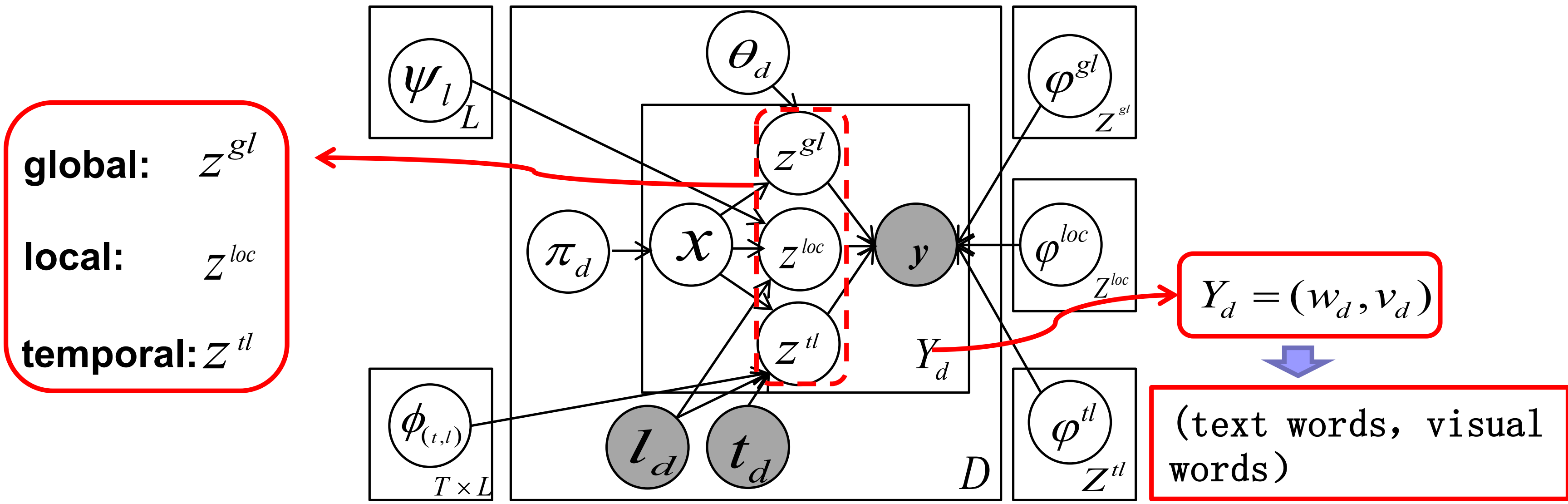
中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences

Three kinds of themes

- Global theme z^{gl} : shared by all landmarks
- Local theme z^{loc} : landmark specific unique physical and historical characteristics
- Temporal theme z^{tl} : time-specific theme from one landmark

Spatio-Temporal Theme Modeling

- The graphical representation



Spatio-Temporal Theme Modeling

- Log-likelihood of the dataset

$$L(D) = \sum_{d \in D} \sum_{y \in Y} n(d,n) \times \log[p(x = gl|d) \sum_{z \in Z^{gl}} \theta_{d,z} \varphi^{gl}_{z,y} \times p(x = loc|d) \sum_{z \in Z^{loc}} \psi_{l_d,z} \varphi^{loc}_{z,y} \times p(x = tl|d) \sum_{z \in Z^{tl}} \phi_{(t_d,l_d),z} \varphi^{tl}_{z,y}$$

- Mutual-Information-Based Regularization

$$\max(L(D) + \boxed{\lambda_1 I_l(L; Z^{loc}) + \lambda_2 I_{(l,t)}((L,\ T);\ Z^{lt})}$$

$$I_l(L; Z^{loc}) \triangleq \sum_{l \in L} \sum_{z \in Z^{loc}} p(l,z) log \frac{p(l,z)}{p(l)p(z)} \qquad I_{(l,t)}((L,T); Z^{lt}) \triangleq \sum_{(t,l) \in (L,T)} \sum_{z \in Z^{lt}} p((l,t),z) log \frac{p((l,t),z)}{p((l,t))p(z)}$$

- Parameter Estimation EM

Spatio-Temporal Theme Modeling

- Time distribution of theme for one landmark

$$p(t|z,l) = \frac{\phi_{(l,t)} p(t,l)}{\sum_{t' \in T} \phi_{(l,t')} p(t',l)}$$

- Location distribution of theme for a time interval

$$p(l|z,t) = \frac{\phi_{(l,t)} p(t,l)}{\sum_{l' \in L} \phi_{(t,l')} p(t,l')}$$

Experiment

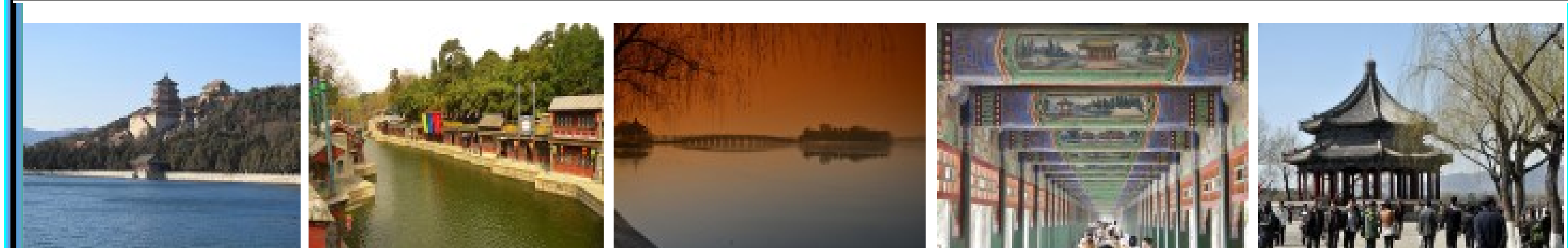
- Dataset
  - 20 landmarks from 6 countries
  - 435,810 images, 22,703 words
  - Jan 01, 2010 to Dec 31, 2012

Landmark	Landmark
Arc De Triomphe	Big Ben
Brooklyn Bridge	Buckingham Palace
Eiffel Tower	Washington Monument
Forbidden City	Golden Gate Bridge
Great Wall	Kiyomizu-dera
London Eye	Lincoln Memorial
Statue of Liberty	Notre Dame
Summer Palace	Sydney Opera House
Tokyo Tower	Tower Bridge
Trafalgar Square	White House

Theme visualization

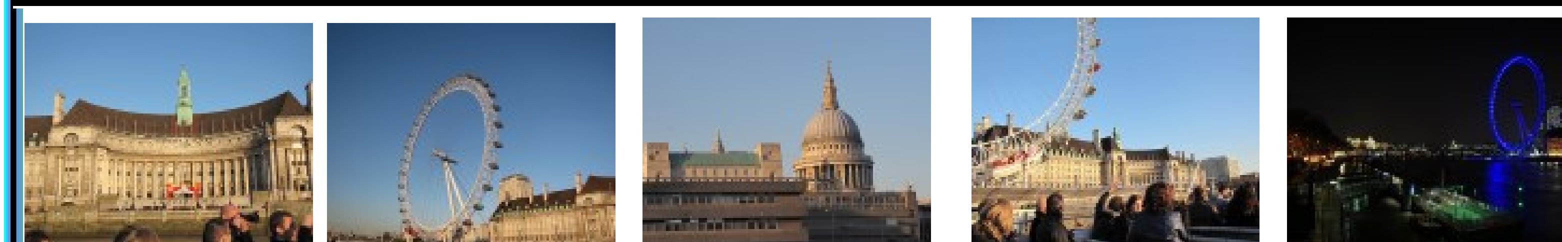
$$sim(Z_i, d_j) = \frac{(\mathbf{w}_{z_i}, \mathbf{v}_{z_i})(\mathbf{w}_{d_j}, \mathbf{v}_{d_j})}{|(\mathbf{w}_{z_i}, \mathbf{v}_{z_i})||(\mathbf{w}_{d_j}, \mathbf{v}_{d_j})|}$$

Local #5



0.157004	0.152931	0.152222	0.150788	0.150391

Local #26



0.135706	0.135705	0.131267	0.130258	0.126970

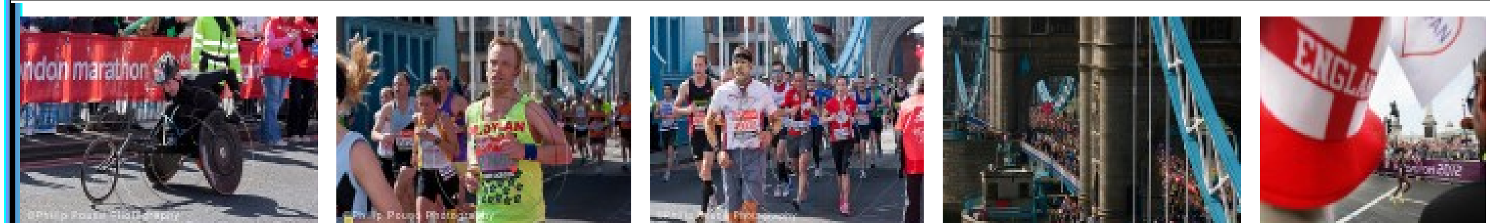
Theme visualization

$$sim(Z_i, d_j) = \frac{(\mathbf{w}_{z_i}, \mathbf{v}_{z_i})(\mathbf{w}_{d_j}, \mathbf{v}_{d_j})}{|(\mathbf{w}_{z_i}, \mathbf{v}_{z_i})||(\mathbf{w}_{d_j}, \mathbf{v}_{d_j})|}$$

Temporal #67

0.101686 **0.101680** **0.101607** **0.101482** **0.101471**

Temporal #70



0.203266 **0.203159** **0.202948** **0.185978** **0.183135**

Quantitative evaluation

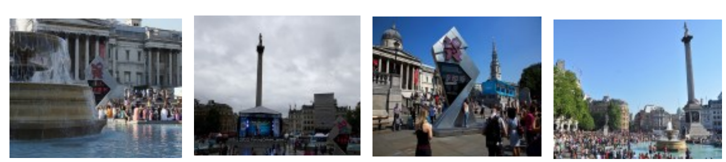
Metric： number of discovered local themes and temporal themes

♯ Methods	♯ local themes	♯ temporal themes
PLSA	17	22
TM	20	25
mmSTTM_Text	27	39
mmSTTM	30	45

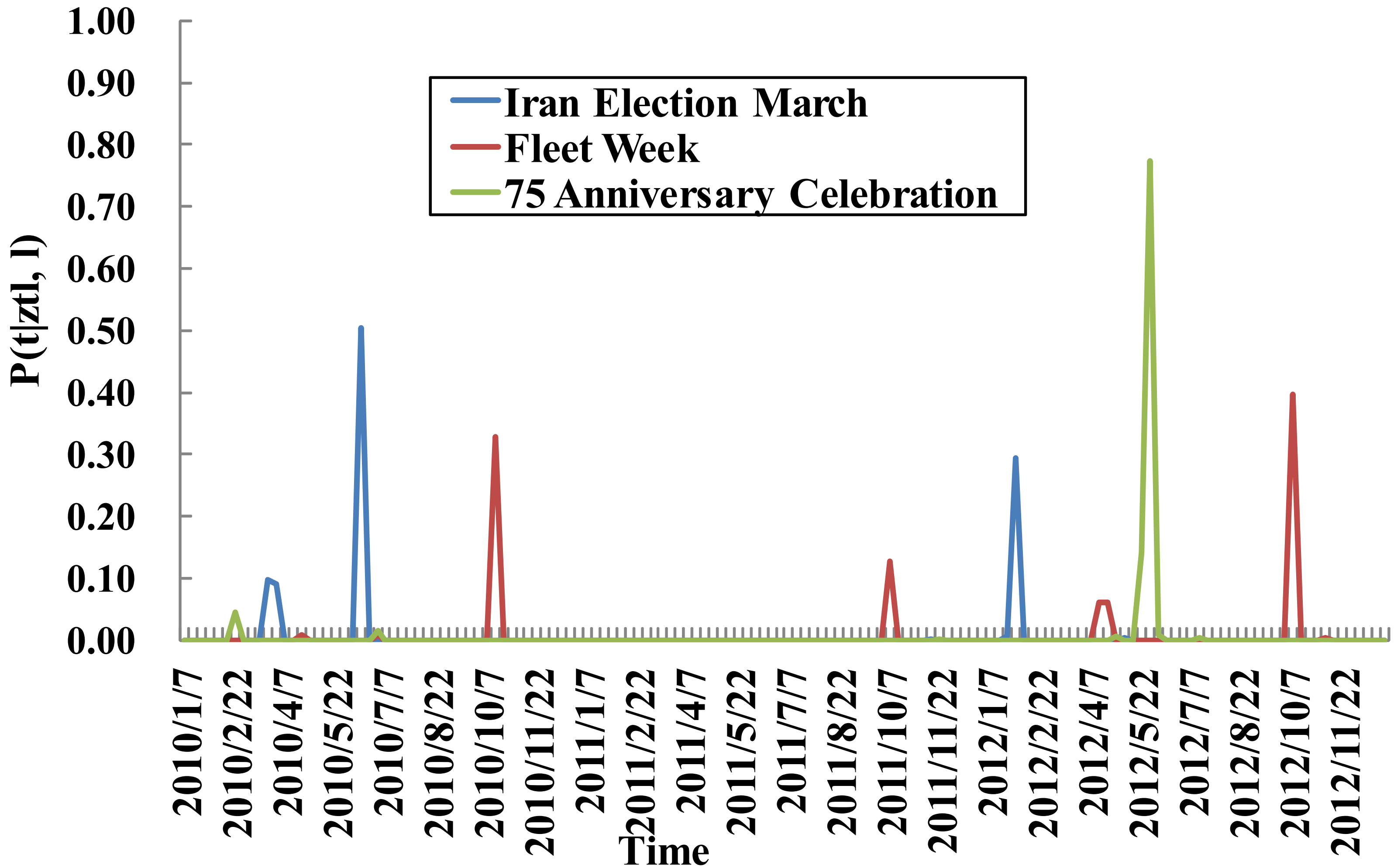
Metric： MAP for number of discovered themes

♯ Methods	MAP@10 For Words	MAP@10 For Photos
PLSA	0.6188	0.5887
TM	0.6867	0.6368
mmSTTM_Text	0.7837	0.7411
mmSTTM	0.8399	0.8025

Location distribution of themes

Landmarks	$P(l \mid z_{tl}, t)$	07/22/2012-07/31/2012 Relevant photos
Tower Bridge	0.64	
Big Ben	0.30	
London Eye	0.05	
Buckingham Palace	0.003	
Trafalgar Square	0.0001	

Temporal distribution of themes



Two Applications

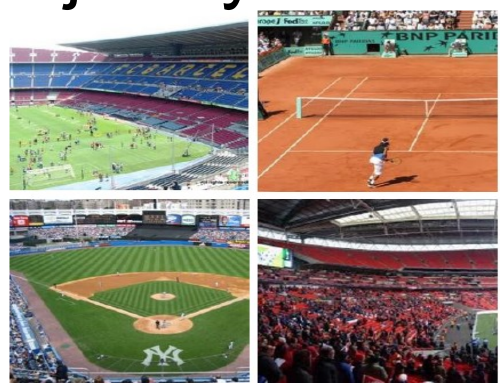
- Landmark Analysis

- **Cross-Region Food Analysis**

Motivation

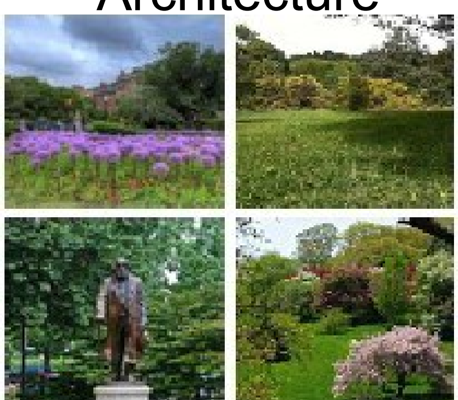
- Each region/country/city has formed a distinct identity, distinguishing itself from other regions
- Different aspects jointly determine the identity

Architecture



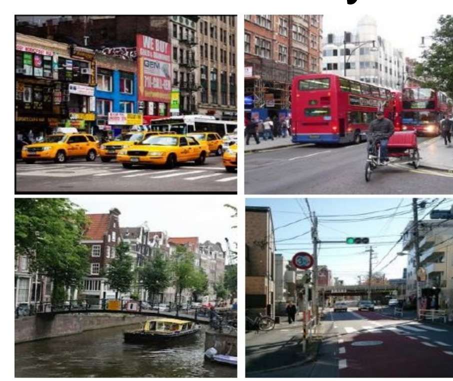
Athletic activity

Social activity



Vegetation

Food



Transportation

Motivation

- Food has always been a significant aspect of region identity.
- The Food recipes from different regions are strong signals of the culinary habits of individuals from various parts of the world
  - Food ingredients: East Asian: “soy sauce ” and “sesame oil”
  - Food flavor: The flavor of Asian is more similar than Europe
  - Food visual appearance
  - ……
- Cross-region food analysis
  - can facilitate deep understanding of food from the health, marketing and cultural perspectives
  - Enable various applications: food preference learning and recommendation, cuisine classification and health diet analysis

Motivation-Data Collection

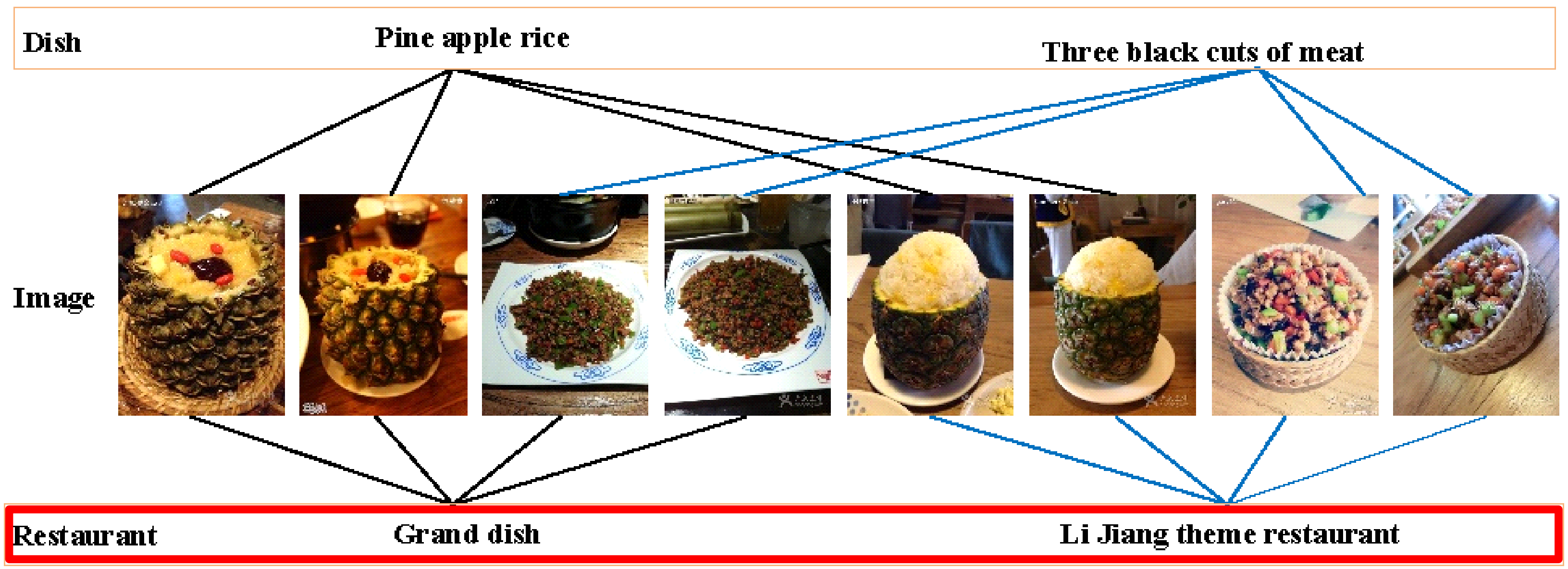
Recipe-Sharing Website:Yummly

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

中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences

Venue Review Website: Dianping



Our Data Collection: Yummly-66K

- Data Collection
  - 66,615 recipes
  - Each recipe: food image, ingredients, course, cuisine(region)

#items	#Cuisine	#Course	#ingredients
66,615	10	13	2,416

Cuisine	♯items	Cuisine	♯items
American	13,262	Italian	9,401
Greek	4,998	Japanese	4,804
Mexican	7,960	Indian	5,470
French	6,173	Spanish	4,014
Thai	5,282	Chinese	5,251

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

Our Data Collection: Yummly-66K

- Data Collection

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

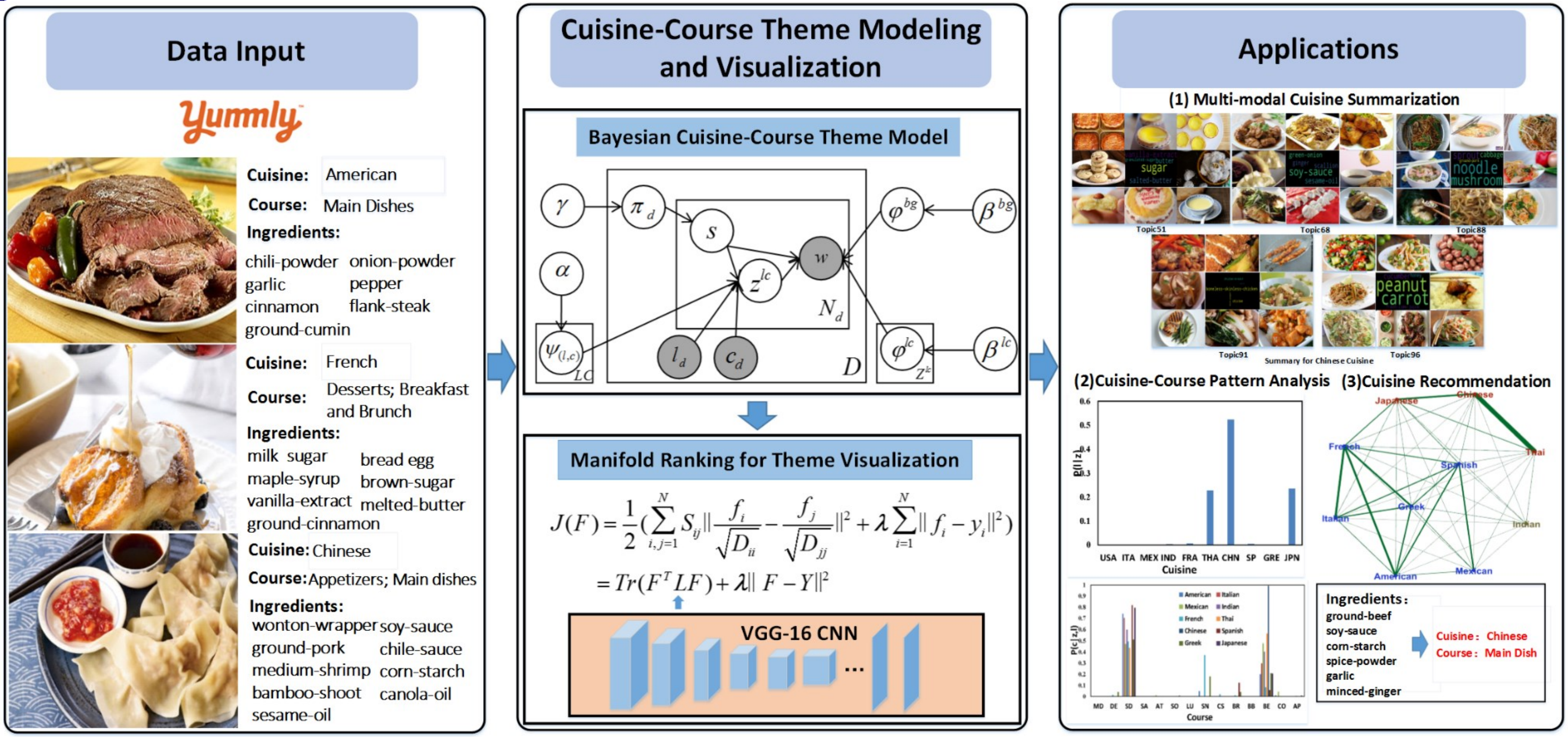
Cuisine Chinese

Course Appetizers; Main Dishes

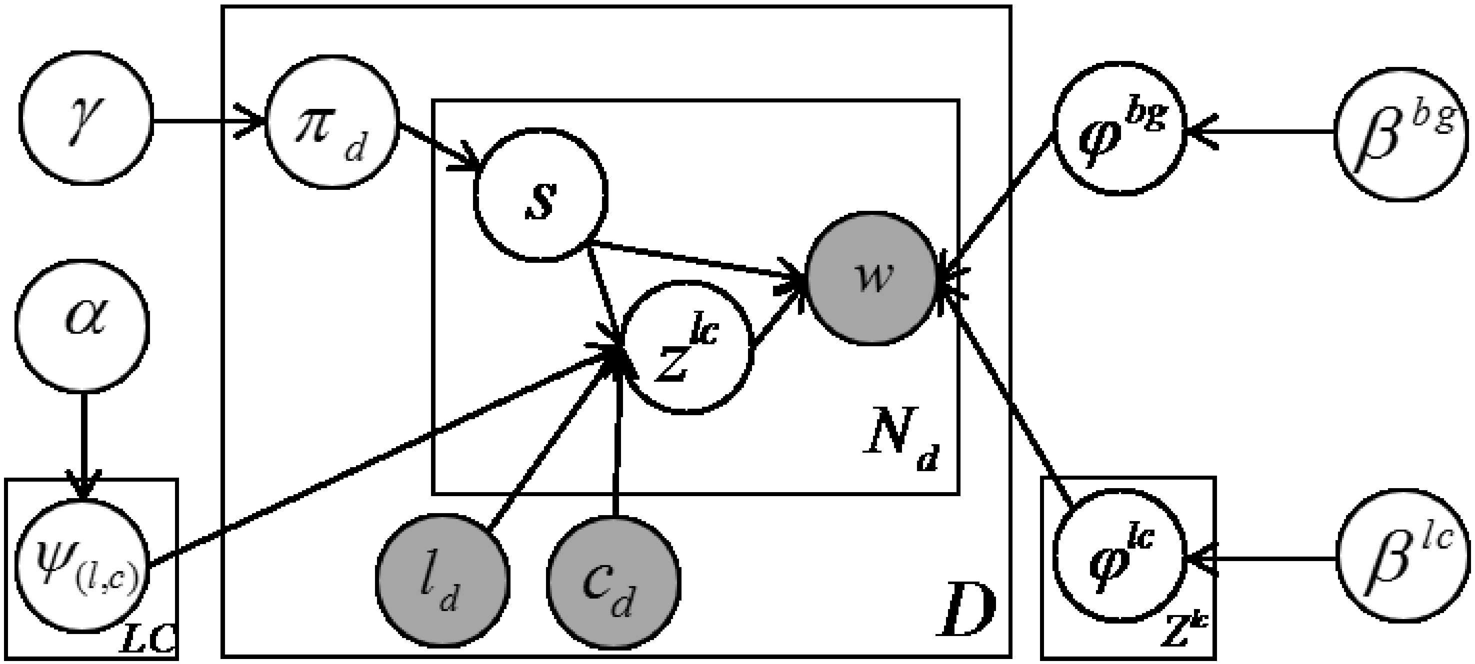
Ingredients medium-shrimp ground-pork bamboo-shoot canola-oil sesame-oil ground-white-pepper wonton-wrapper corn-starch soy-sauce chile-sauce

Solution

中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences



Bayesian Cuisine-Course Theme Model



- w: the ingredients
- l_d: the cuisine label
- c_d: the course label

Bayesian Cuisine-Course Theme Model

- Generative Process

1) Draw a distribution over ingredients $\varphi^{bg} \sim Dir(\boldsymbol{\beta}^{bg})$ for the background theme
2) For each cuisine-course theme $z \in \{1, ..., Z^{lc}\}$, draw a multinomial distribution $\varphi_z^{lc} \sim Dir(\boldsymbol{\beta}^{lc})$ over ingredients
3) For each cuisine-course pair $(l, c) \in \{1, ..., LC\}$, draw a multinomial distribution $\psi_{(l,c)} \sim Dir(\boldsymbol{\alpha})$ over cuisine-course themes.
4) For each recipe $d \in \{1, ..., D\}$
   a) draw $\pi_d \sim Beta(\boldsymbol{\gamma})$,
   b) for each ingredient $w_{d,n} \in \mathbf{w}_d$
      i) Draw a switch variable $s_{d,n} \sim Binomial(\pi_d)$
      ii) if $s_{d,n} = bg$
      draw an ingredient $w_{d,n} \sim Multi(\varphi^{bg})$
      iii) if $s_{d,n} = lc$
      draw a theme $z_{d,n} \sim Multi(\psi_{(l_d, c_d)})$
      draw an ingredient $w_{d,n} \sim Multi(\varphi^{lc}_{z_{d,n}})$

Bayesian Cuisine-Course Theme Model

- Model Inference

(i) sample s given the current estimate of **z**

$$p(s_i = bg|w = w_i, \mathbf{s}_{\neg i}, \mathbf{z}_{\neg i}, \mathbf{w}_{\neg i})$$
$$\propto \frac{n^{bg}_{w_i,\neg i} + \beta^{bg}}{\sum_{w'} n^{bg}_{w',\neg i} + W\beta^{bg}} \frac{n_{d,s_i,\neg i} + \lambda}{n_{d,bg,\neg i} + n_{d,lc,\neg i} + 2\lambda}$$

$$p(s_i = lc|z_i, w = w_i, \mathbf{s}_{\neg i}, \mathbf{z}_{\neg i}, \mathbf{w}_{\neg i})$$
$$\propto \frac{n^{lc}_{(l_d,c_d),z_i,\neg i} + \alpha}{\sum_z n^{lc}_{(l_d,c_d),z,\neg i} + Z\alpha} \frac{n_{d,s_i,\neg i} + \lambda}{n_{d,bg,\neg i} + n_{d,lc,\neg i} + 2\lambda}$$

(ii) sample **z** given the current estimate of s

$$p(z_i|s_i = lc, w = w_i, \mathbf{z}_{\neg i}, \mathbf{s}_{\neg i}, \mathbf{w}_{\neg i})$$
$$\propto \frac{n^{lc}_{z_i,w_i,\neg i} + \beta^{lc}}{\sum_{w'} n^{lc}_{z_i,w',\neg i} + W\beta^{lc}} \frac{n^{lc}_{(l_d,c_d),z_i,\neg i} + \alpha}{\sum_{z'} n^{lc}_{(l_d,c_d),z',\neg i} + Z\alpha}$$

Bayesian Cuisine-Course Theme Model

- Parameter estimation

$$\hat{\pi}_{d,s} = \frac{n_{d,s} + \gamma}{n_{d,bg} + n_{d,lc} + 2\gamma} \qquad s \in \{bg, lc\}$$

$$\hat{\psi}_{(l,c),z} = \frac{n^{lc}_{(l,c),z} + \alpha}{\sum_{z'} n^{lc}_{(l,c),z'} + Z\alpha}$$

$$\hat{\varphi}^{bg}_{w} = \frac{n^{bg}_{w} + \beta^{bg}}{\sum_{w'} n^{bg}_{w'} + W\beta^{bg}}$$

$$\hat{\varphi}^{lc}_{z,w} = \frac{n^{lc}_{z,w} + \beta^{lc}}{\sum_{w'} n^{lc}_{z,w'} + W\beta^{lc}}$$

Theme Visualization-Manifold ranking

$$J(F) = \frac{1}{2}\left(\sum_{i,j=1}^{N} S_{ij} \left\| \frac{f_i}{\sqrt{D_{ii}}} - \frac{f_j}{\sqrt{D_{jj}}} \right\|^2 + \lambda \sum_{i=1}^{N} \| f_i - y_i \|^2\right) \quad (5)$$

$$= Tr(F^T L F) + \lambda \|F - Y\|^2 \quad (6)$$

$$\min_F \{ Tr(F^T U F) + \lambda \|F - Y\|^2 \}$$

VGG-16 deep features

$$y_{(l,c),i} = \begin{cases} \frac{\hat{\boldsymbol{\varphi}}_z^{lc} \mathbf{w}_{d_i}^T}{|\hat{\boldsymbol{\varphi}}_z^{lc}||\mathbf{w}_{d_i}|} & (l,c) \in o \\ 0 & otherwise \end{cases}$$

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Applications

1. Multi-modal cuisine summarization
2. Cuisine-course pattern analysis
3. Cuisine recommendation

Applications

- Multi-modal cuisine summarization

$$p(z|l_q) = \frac{p(z,l_q)}{p(l_q)} = \frac{\sum_{c\in C} p(z,l_q,c)}{\sum_{c\in C} p(l_q,c)} = \frac{\sum_{c\in C} \psi_{(l_q,c),z} p(l_q,c)}{\sum_{c\in C} p(l_q,c)} \quad (11)$$

- Cuisine-Course Pattern Analysis

$$p(l|z) = \frac{p(l,z)}{p(z)} = \frac{\sum_{c'\in C} p(l,z,c')}{\sum_{c'\in C}\sum_{l'\in L} p(z|c',l')p(c',l')}$$

$$= \frac{\sum_{c'\in C} \hat{\psi}_{(l,c'),z} p(c',l)}{\sum_{c'\in C}\sum_{l'\in L} \hat{\psi}_{(c',l'),z} p(c',l')}$$

$$p(c|z,l) = \frac{\hat{\psi}_{(l,c),z} p(c,l)}{\sum_{c'\in C} \hat{\psi}_{(l,c'),z} p(c',l)}$$

Applications

- Cuisine Recommendation
  - Being similar to a given cuisine. "I quite enjoyed the Chinese food. Are there any other cuisines with similar style?"
  - Being relevant to a given cooking. "I have some ingredients at hand, what kind of cuisine and course do I can cook?"

（1）

$$CuiSim(l_i, l_j) = \exp\{-\frac{D_{js}(\psi_{l_i} || \psi_{l_j})}{2\sigma^2}\}$$

$$\psi_l = \{p(z|l)\}_{z \in Z}$$

（2）

$$p((l,c)|d_q) = \sum_z p((l,c)|z)p(z|d_q)$$

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Experiment

- Evaluation of Theme Model
- Evaluation of Theme Visualization
- Evaluation of Multi-modal Cuisine Summarization
- Evaluation of Cuisine-Course Pattern Analysis
- Evaluation of Cuisine Recommendation

Evaluation of the theme model

- Some examples of discovered themes

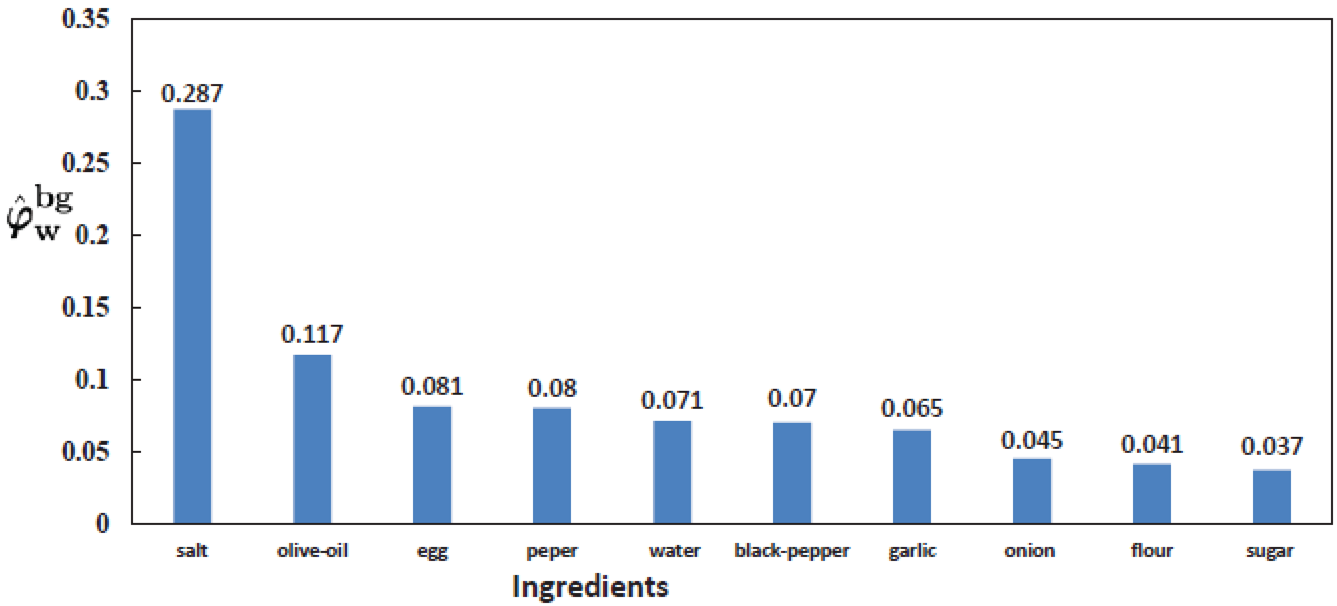
Topic ♯68	Topic ♯88	Topic ♯91
soy-sauce 0.195	noodle 0.059	boneless-skinless-chicken 0.236
sesame-oil 0.079	mushroom 0.046	chicken 0.102
green-onion 0.066	cabbage 0.035	chicken-breast 0.089
scallion 0.060	sprout 0.034	bell-pepper 0.040
ginger 0.054	ground-pork 0.030	onion 0.035
fresh-ginger 0.049	star-anise 0.030	chicken-thigh 0.035
sugar 0.049	baby-bok-choy 0.029	boneless-chicken-breast 0.029
rice-vinegar 0.039	bok-choy 0.028	shrimp 0.028
vegetable-oil 0.037	chicken 0.026	ground-pepper 0.027
water 0.036	firm-tofu 0.025	beef 0.018

Topic ♯89	Topic ♯12	Topic ♯91
mango 0.093	butter 0.074	boneless-skinless-chicken 0.236
coconut-milk 0.085	flour 0.062	chicken 0.102
milk 0.080	ground-cinnamon 0.056	chicken-breast 0.089
ice-cube 0.0691	vanilla-extract 0.042	bell-pepper 0.040
water 0.064	salted-butter 0.039	onion 0.035
tea 0.0377	milk 0.037	chicken-thigh 0.035
coconut 0.034	sugar 0.037	boneless-chicken-breast 0.029
thai-basil 0.023	chopped-pecan 0.033	shrimp 0.028
sticky-rice 0.022	sour-cream 0.029	ground-pepper 0.027
banana 0.021	vegetable-oil 0.029	beef 0.018

中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences

Evaluation of the theme model

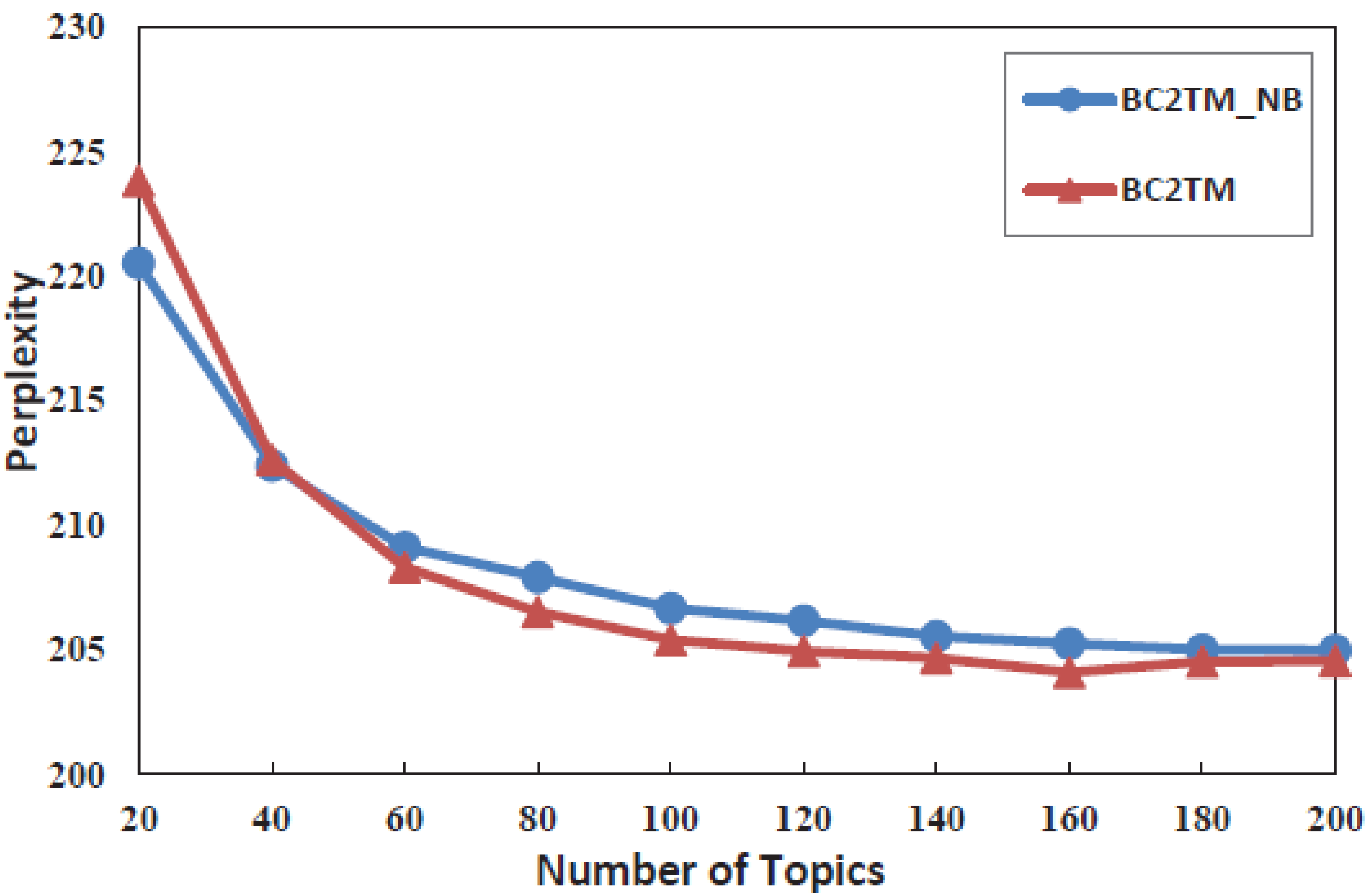
- Background themes



中科院计算所
Institute of Computing Technology, Chinese Academy of Sciences

Evaluation of the theme model

- Perplexity

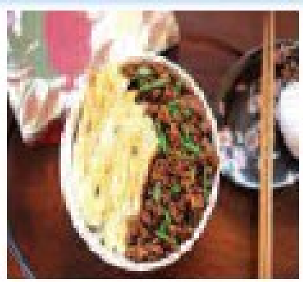
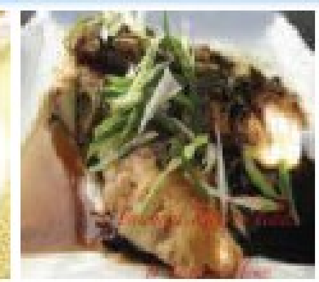


中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Evaluation of Theme Visualization

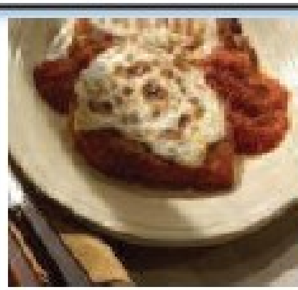
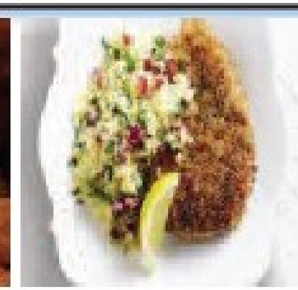
Theme ♯68
soy-sauce 0.195
sesame-oil 0.079
green-onion 0.066
scallion 0.060
ginger 0.054
fresh-ginger 0.049
sugar 0.049
rice-vinegar 0.039
vegetable-oil 0.037

Images	 0.416	 0.383	 0.366	 0.352	 0.349
recipe	Sesame Oil Chicken	Beef Soboro	Japanese-Noodle-Sauce-Base	Chinese-Braised-Potatoes	Chinese-Pan-Fried-Red-Rockfish-Fillets
cuisine	Chinese	Japanese	Japanese	Chinese	Chinese

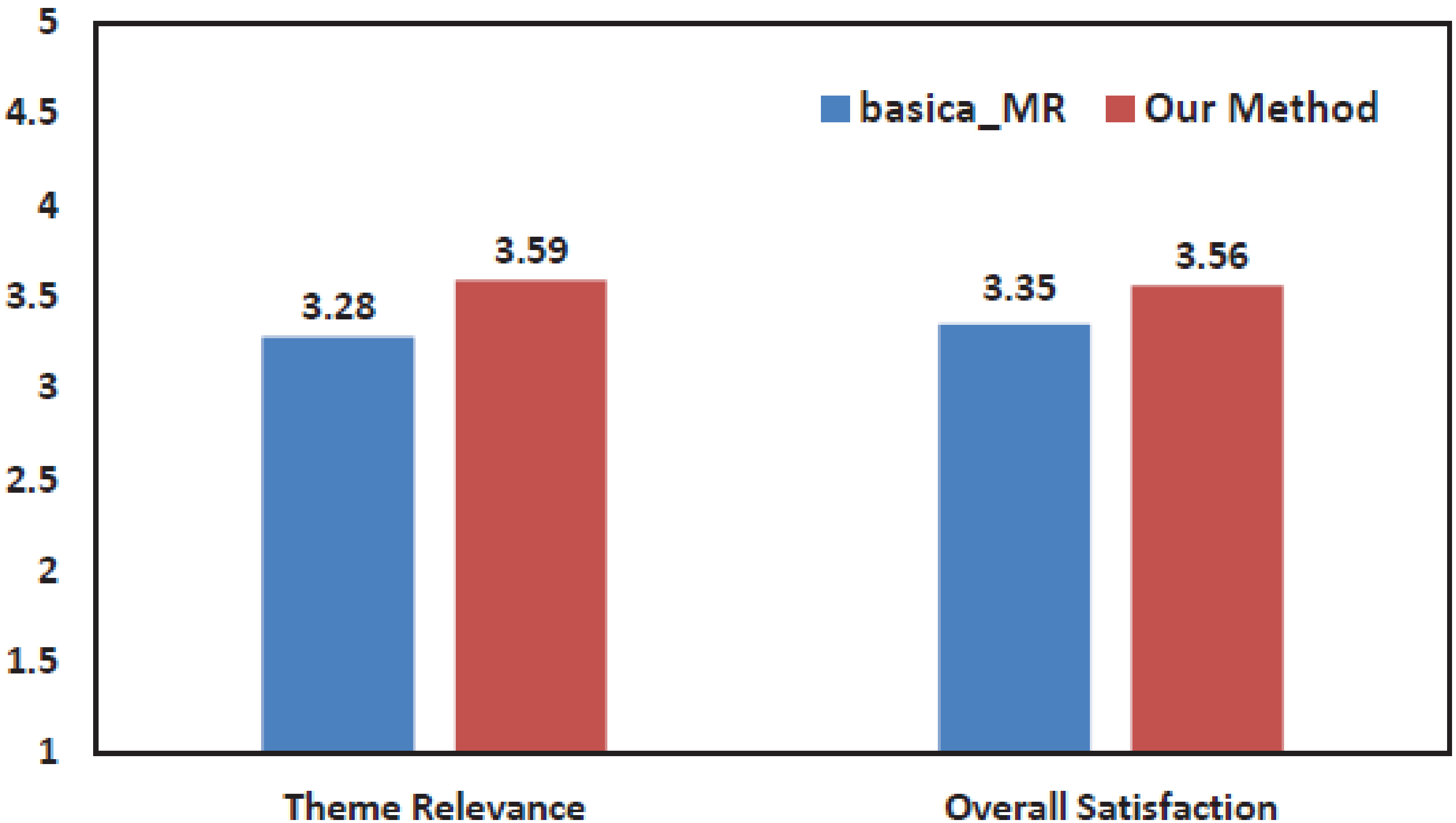
Evaluation of Theme Visualization

Theme ♯91
boneless-skinless-chicken 0.236
chicken 0.102
chicken-breast 0.089
bell-pepper 0.040
onion 0.035
chicken-thigh 0.035
boneless-chicken-breast 0.029
shrimp 0.028
ground-pepper 0.027
beef 0.018

Theme #91

Images	 0.306	 0.281	 0.277	 0.271	 0.264
recipe	Chicken Parmigiana-Martha Stewart	Italian Chicken With Basil	Homemade Baked Chicken-Nuggets	Allfoodrecipes	Middle Eastern Crispy Chicken
cuisine	Italian	Italian	Japanese	Thai	Japanese

Evaluation of Theme Visualization



Multi-modal cuisine summarization

- Chinese Cuisine

(a) Summary for Chinese Cuisine

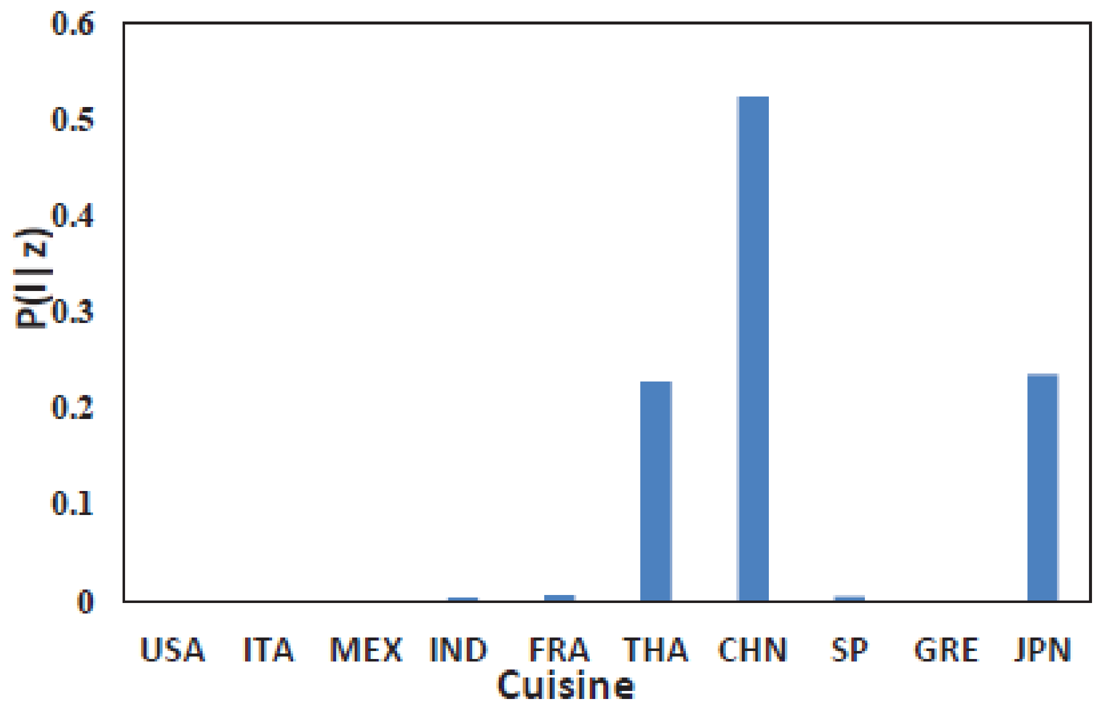
Multi-modal cuisine summarization

- Italian Cuisine

Cuisine-Course Pattern Analysis

- Cuisine distribution conditioned on certain theme

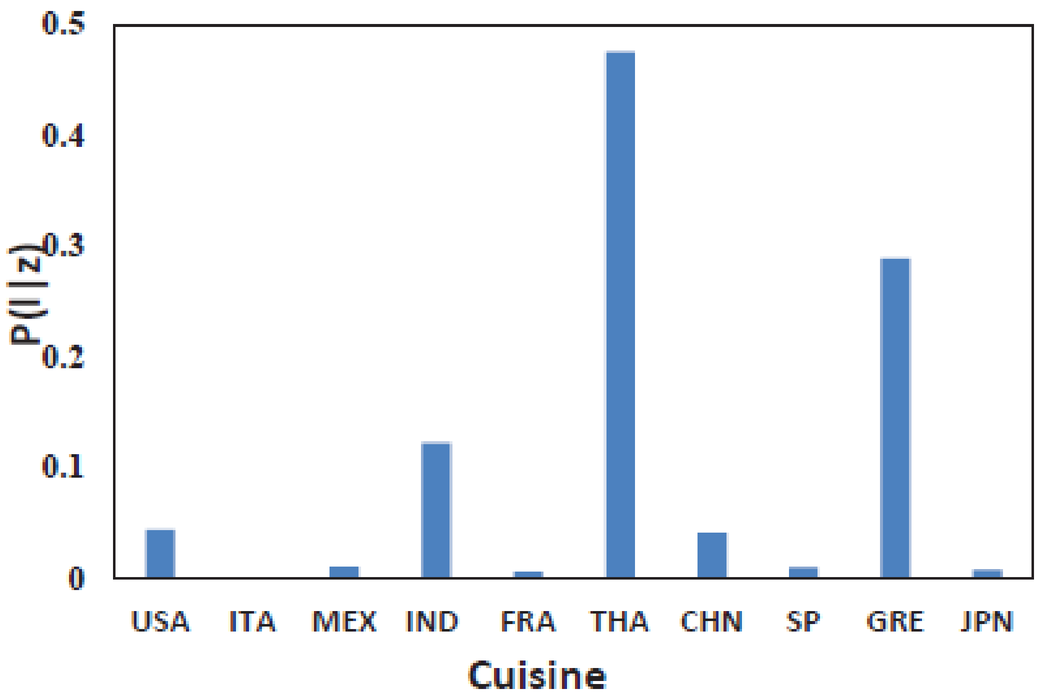
Theme ♯68
soy-sauce 0.195
sesame-oil 0.079
green-onion 0.066
scallion 0.060
ginger 0.054
fresh-ginger 0.049
sugar 0.049
rice-vinegar 0.039
vegetable-oil 0.037
water 0.036



Cuisine-Course Pattern Analysis

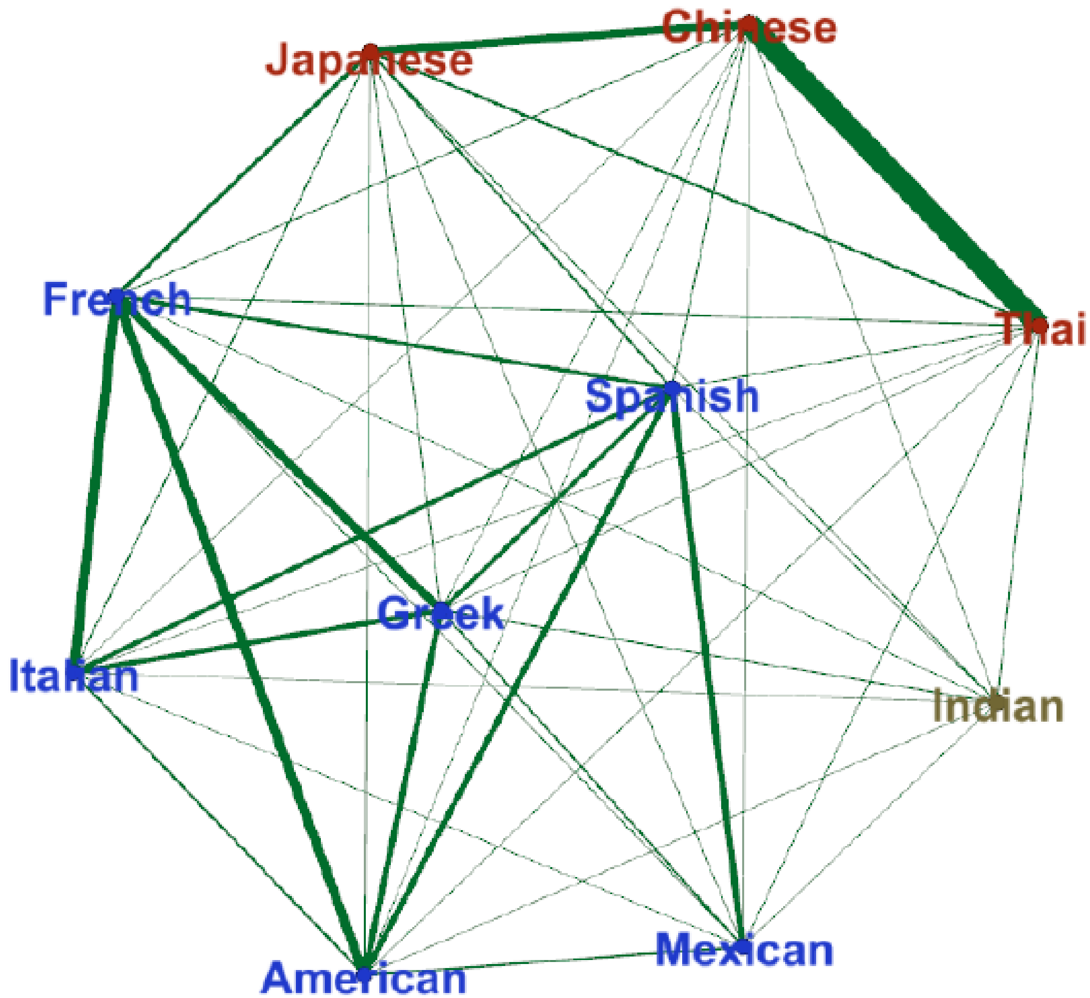
- Cuisine distribution conditioned on certain theme

Theme ♯89
mango 0.093
coconut-milk 0.085
milk 0.080
ice-cube 0.0691
water 0.064
tea 0.0377
coconut 0.034
thai-basil 0.023
sticky-rice 0.022
banana 0.021



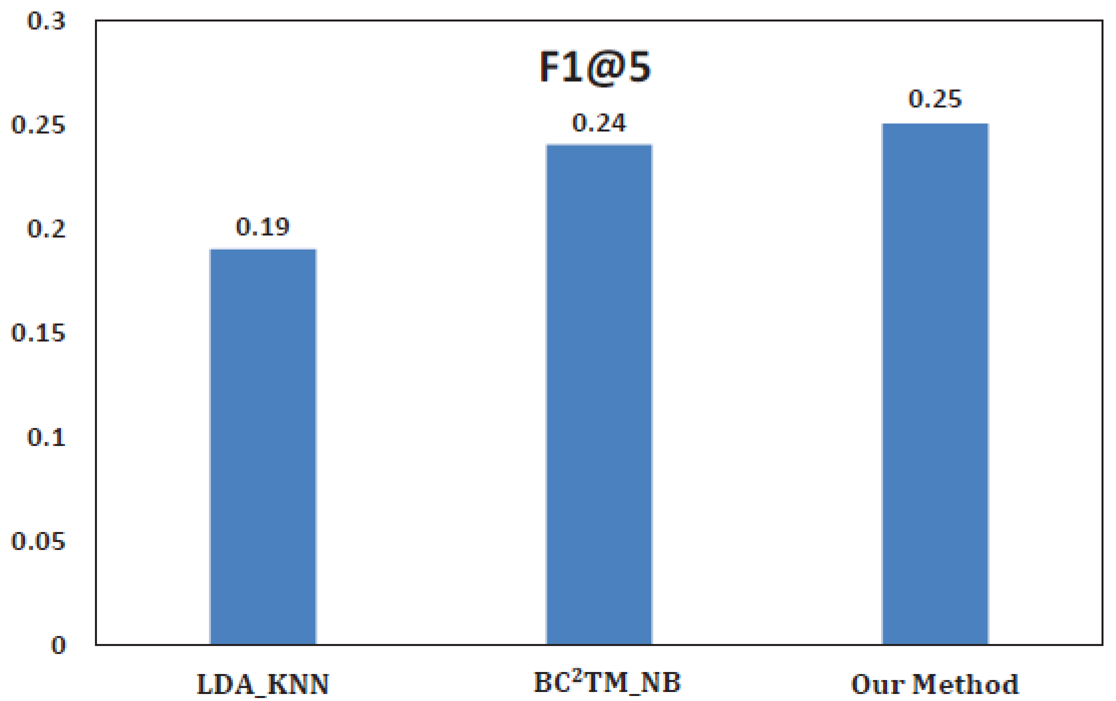
Cuisine Recommendation

- Cuisine similarity graph



Cuisine Recommendation

- Recommend both relevant cuisine and course information give the ingredients.



Outline

- Introduction
- Two cases
  - Landmark Analysis
  - Cross-Region Food Analysis
- Conclusions

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Conclusions

- propose a multi-modal multi-attribute topic modeling and analysis framework, which is capable of discovering themes conditioned on different attributes and visualizing them for landmarks and recipes.
- Collect a real-world multi-modal multi-attribute landmark/ recipe dataset Landmark-20 and Yummly-66K (**http://isia.ict.ac.cn/dataset**)

Future Work

- Geo-multimedia computer vision: e.g. high-level attribute learning, large-scale visual feature learning
- Geo-multimedia knowledge graph construction and learning
- Cross-platform geo-multimedia correlation modeling
- Explore more interesting and useful applications in vertical fields and interdisciplinary fields

Reference

- **Weiqing Min**, Bing-kun Bao, Changsheng Xu. Multi-modal Spatio-Temporal Theme Modeling for Landmark Analysis. ***IEEE Multimedia Magazine (IEEE MM).*** 21(3): 20-29 (**2014**) ***(2017 Best Paper Award)***
- **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(TMM)*** 19(5): 1100-1113 (**2017**)
- **Weiqing Min**, Shuqiang Jiang, et al. A Delicious Recipe Analysis Framework for Exploring Multi-Modal Recipes with Various Attributes***. ACM Multimedia 2017*** **(accepted)**
- **Weiqing Min**, Shuqiang Jiang, Bing-Kun Bao, Shuhuan Mei, Yaohui Zhu, Yong Rui : You Are What You Eat: Exploring Multi-modal and Multi-attribute Information from Recipes for Cross-Region Food Analysis. ***Transactions on Multimedia (TMM) 2017 (Minor revision)***

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

中科院计算所

Institute of Computing Technology, Chinese Academy of Sciences

Thank you!