Recommend Places by Spatial and Non-Spatial Features

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Introduction

Coordinates ← Space → Meaning → Place → Place Names / POIs
Location-based recommender systems provide relevant suggestions to users by integrating location information.

These could include recommendations for hotels, restaurants, parks or other places near the user's location.

Place recommendation would not recommend only near places.

A recommender system of tourism should focus on attractiveness of places rather than their locations.

These systems focus only on the general area of places, not on their exact locations.

A place may be very attractive, but it is so far away that users will avoid visiting it.

A Place recommender system which consider spatial and non-spatial features
Extract meaningful place-based concepts from UGTCs and suggest places, which is applicable in recommender systems.

Consider semantic spaces consisting of objects from some particular domain (e.g., TripAdvisor place reviews).

Such semantic spaces often model salient features (e.g., attractiveness). The feature directions allow us to rank objects according to how much they have the corresponding feature.

Our method is fully unsupervised, requiring only a bag-of-words representation of the objects as input.
Toy example: A 2-D embedding of geometric shapes

Within this space: Identify directions which encode
❖ how light an object is and
❖ how closely its shape resembles a square

Workflow

Collecting Data
- TripAdvisor
  - Places
  - Reviews
  - Types
  - Coordinates
- Shapefile
  - NYC
  - Census

Preparing
- Remove Places without Coordinates or Types
- Remove Places Out of Study Area or Duplicates

Extracting Functionality

Preprocessing
- Tokenization → Remove Stop Words → Lemmatization → POS Tagging

Extracting Functionality
- BOW → TF-IDF → MDS
- LDA → Cosine Similarity → Assign Topics
- Dictionary
- Evaluation → Functionality
- Probabilities → Distances

Recommend Places
- Semantic Distances
- Geographic Distances
- Rank Places
Tripadvisor

Times Square

### Overview
Central area in NYC that has many shops, restaurants, office buildings and families walking around.

#### Suggested Duration
1-2 hours

#### Address
Broadway, New York City, NY 10036

#### Improves This Listing

<table>
<thead>
<tr>
<th>PlaceID</th>
<th>ReviewID</th>
<th>ReviewTitle</th>
<th>reviewText</th>
<th>reviewRating</th>
</tr>
</thead>
<tbody>
<tr>
<td>20053947</td>
<td>747586682</td>
<td>WOW</td>
<td>So glad I made it to this exhibit. An &quot;experience&quot; is exactly right - the room was filled with beautiful vibes and people, and we had a wonderful time.</td>
<td>5</td>
</tr>
<tr>
<td>20053947</td>
<td>744159299</td>
<td>Tantalizing!</td>
<td>Amazing Experience. I thought I was on another planet. The music was a big part of this event in my opinion.</td>
<td>5</td>
</tr>
<tr>
<td>20053947</td>
<td>743400695</td>
<td>Epic art experience!</td>
<td>It was such an amazing experience!!! Such a talented artist !!! I highly recommend checking it out! Something you don’t want to miss.</td>
<td>5</td>
</tr>
<tr>
<td>20053947</td>
<td>743586384</td>
<td>2120: An Art Experience</td>
<td>Absolutely loved! It’s hard to find art that’s fun to play with, so Instagrammable and different. Had a great time experiencing the installati</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Tripadvisor Categories
- 0: The innovative master works of leading Art Galleries
- 1: Founded in 2014 in New York City’s East Village Art Galleries
- 2: Produced by YIG Agency, 2120: An Art Experience
- 3: 242 Grand Jewelry is part storefront part Gift Specialty Shop
- 4: Chelsea Flea Market evokes the original Flea Market
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- Extracting Functionality
  - BOW → TF-IDF → MDS → LR
  - LDA → Cosine Similarity → Assign Topics
  - Dictionary → Evaluation → Functionality
  - Evaluation → Probabilities → Distances

Recommend Places
- Semantic Distances
- Geographic Distances
- Rank Places
Workflow
The Thematic View of The Semantic Space

❖ A topic for each functionality (4 topics)

❖ MDS Dimensions are the constant number of dimensions to convert BoW to lower dimensional similarity space (D=5, 10, 20, 50)

❖ A hyperplane for each functionality (4 hyperplanes)
Topic Modeling LDA

Attractions

Foodplaces

Hotels

Shoppings
Sample of Predicted Functionalities

<table>
<thead>
<tr>
<th>TripAdvisor</th>
<th>Predicted</th>
<th>Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attraction</td>
<td>Attraction</td>
<td>[7.976, -4.076, 7.348, 4.300]</td>
</tr>
<tr>
<td>Attraction</td>
<td>FoodPlace</td>
<td>[-18.809, 16.044, -51.044, -8.239]</td>
</tr>
<tr>
<td>Attraction</td>
<td>Hotel</td>
<td>[24.275, -68.621, 30.069, 10.392]</td>
</tr>
<tr>
<td>Attraction</td>
<td>Shopping</td>
<td>[11.399, -16.329, -4.216, 13.422]</td>
</tr>
<tr>
<td>Attraction</td>
<td>Unclassified</td>
<td>[-6.158, -63.251, -37.637, -43.335]</td>
</tr>
<tr>
<td>FoodPlace</td>
<td>Attraction</td>
<td>[11.024, 9.74, -43.903, -10.894]</td>
</tr>
<tr>
<td>FoodPlace</td>
<td>FoodPlace</td>
<td>[-10.372, 76.230, -56.525, 1.929]</td>
</tr>
<tr>
<td>FoodPlace</td>
<td>Hotel</td>
<td>[9.236, 7.277, 17.749, 13.212]</td>
</tr>
<tr>
<td>FoodPlace</td>
<td>Shopping</td>
<td>[8.058, -1.743, 7.158, 9.104]</td>
</tr>
<tr>
<td>FoodPlace</td>
<td>Unclassified</td>
<td>[-11.587, -46.167, -8.320, -16.781]</td>
</tr>
<tr>
<td>Hotel</td>
<td>Attraction</td>
<td>[14.775, -47.845, 13.027, 1.870]</td>
</tr>
<tr>
<td>Hotel</td>
<td>FoodPlace</td>
<td>-</td>
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<tr>
<td>Hotel</td>
<td>Hotel</td>
<td>[25.224, -61.947, 89.383, 28.718]</td>
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<tr>
<td>Hotel</td>
<td>Shopping</td>
<td>[66.003, 34.351, 68.137, 74.605]</td>
</tr>
<tr>
<td>Hotel</td>
<td>Unclassified</td>
<td>[-11.687, -46.167, -8.320, -16.781]</td>
</tr>
<tr>
<td>Shopping</td>
<td>Attraction</td>
<td>[-20.790, 4.170, -30.412, -14.821]</td>
</tr>
<tr>
<td>Shopping</td>
<td>FoodPlace</td>
<td>[-15.804, 11.622, 0.685, -1.533]</td>
</tr>
<tr>
<td>Shopping</td>
<td>Hotel</td>
<td>[29.702, -34.273, 32.2471, 26.964]</td>
</tr>
<tr>
<td>Shopping</td>
<td>Shopping</td>
<td>[21.868, -18.723, 22.697, 27.503]</td>
</tr>
<tr>
<td>Shopping</td>
<td>Unclassified</td>
<td>[-11.587, -46.167, -8.320, -16.781]</td>
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</table>
Evaluation Results

Accuracy of the Proposed Method

<table>
<thead>
<tr>
<th>D=5</th>
<th>D=10</th>
<th>D=15</th>
<th>D=20</th>
<th>D=30</th>
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<tbody>
<tr>
<td>Precision</td>
<td></td>
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<tr>
<td>A</td>
<td>0.11</td>
<td>0.20</td>
<td>0.18</td>
<td>0.22</td>
</tr>
<tr>
<td>F</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
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<tr>
<td>H</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.62</td>
</tr>
<tr>
<td>S</td>
<td>0.00</td>
<td>0.01</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Recall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.43</td>
<td>0.37</td>
<td>0.66</td>
<td>0.66</td>
</tr>
<tr>
<td>F</td>
<td>0.58</td>
<td>0.65</td>
<td>0.65</td>
<td>0.66</td>
</tr>
<tr>
<td>H</td>
<td>0.84</td>
<td>0.87</td>
<td>0.89</td>
<td>0.91</td>
</tr>
<tr>
<td>S</td>
<td>0.02</td>
<td>0.07</td>
<td>0.13</td>
<td>0.04</td>
</tr>
<tr>
<td>F1-Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.17</td>
<td>0.29</td>
<td>0.29</td>
<td>0.33</td>
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<tr>
<td>F</td>
<td>0.74</td>
<td>0.78</td>
<td>0.78</td>
<td>0.79</td>
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<tr>
<td>H</td>
<td>0.74</td>
<td>0.73</td>
<td>0.75</td>
<td>0.74</td>
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<tr>
<td>S</td>
<td>0.01</td>
<td>0.02</td>
<td>0.06</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Distribution Results

![Distribution of Place Functionalities](chart1)

- **Tripadvisor**
  - Attractions: 12.50%
  - Food Places: 72%
  - Hotels: 10.50%
  - Shoppings: 5.00%

- **Proposed Approach**
  - Attractions: 19%
  - Food Places: 51%
  - Hotels: 22.60%
  - Shoppings: 5.80%

![Predicted Place Functionalities](chart2)

- Attractions: 12.70%
- Food Places: 72.05%
- Hotels: 11.13%
- Shoppings: 3.02%
- Wrong Predictions: 6.02%
## Ranked Places Bases on Semantic Space

<table>
<thead>
<tr>
<th>id</th>
<th>categoryType</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>[Sights &amp; Landmarks]</td>
<td>81.44360911</td>
</tr>
<tr>
<td>2</td>
<td>[Museums]</td>
<td>76.17219418</td>
</tr>
<tr>
<td>3</td>
<td>[Sights &amp; Landmarks]</td>
<td>52.18535502</td>
</tr>
<tr>
<td>4</td>
<td>[Sights &amp; Landmarks]</td>
<td>51.357416</td>
</tr>
<tr>
<td>5</td>
<td>[Other]</td>
<td>46.25181251</td>
</tr>
<tr>
<td>6</td>
<td>[Concerts &amp; Shows]</td>
<td>45.07901105</td>
</tr>
<tr>
<td>7</td>
<td>[Other, Nature &amp; Parks, Sights &amp; Landmarks]</td>
<td>41.15674603</td>
</tr>
<tr>
<td>8</td>
<td>[Concerts &amp; Shows]</td>
<td>40.97252379</td>
</tr>
<tr>
<td>9</td>
<td>[Fun &amp; Games, Nature &amp; Parks, Sports Camps &amp; Clinics]</td>
<td>36.1009389</td>
</tr>
<tr>
<td>10</td>
<td>[Nature &amp; Parks, Sights &amp; Landmarks]</td>
<td>36.04665008</td>
</tr>
</tbody>
</table>
Workflow
Summery

❖ The aim was proposing a place recommender system by integrating the geographic space and the semantic space.

❖ The general functionalities were extracted from Tripadvisor reviews.

❖ The semantic space was constructed by modelling salient features as directions for each functionality.

❖ The semantic distances were calculated in this space.

❖ The pairwise geographic distances were calculated in the geographic space.
Limitations and Future works

❖ Insufficient performance for shopping functionality
❖ Looking for an approach to integrate the geographic space and the semantic space
❖ Consider user’s location in ranking approach for place recommender system
Thank you for your attention

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- LinkedIn: https://www.linkedin.com/in/mina-karimi-sama/?originalSubdomain=ir
- X (formerly Twitter): @MinaKarimi_sma