Personalized Food Recommendation as Constrained Question Answering over a Large-scale Food Knowledge Graph

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Contributions
- KBQA-based personalized food recommendation framework.
- Personalization by automatically applying persons focused nutritional guidelines and ingredient constraints.
- Novel techniques to effectively handle numerical comparisons and negations in the queries.
- A QA style benchmark for personalized food recommendation based on a large-scale food KG and health guidelines.

Personalized Food Recommendation

Factors influencing food recommendation:
- Users’ explicit requirements.
- Personal health factors (i.e., allergies and nutrition needs).
- Rich food knowledge for recommending healthy recipes.
- User’s dietary preferences and health guidelines.

Personalized KBQA Benchmark

- A benchmark QA dataset based on the extensive FoodKG [1] knowledge graph.
- Each example in the dataset contains a user query, dietary preferences, health guidelines associated with the user, and the ground-truth answers (i.e., recipe recommendations).
- Ground-truth answers are those recipes from FoodKG that satisfy both explicit requirements and personalized constraints.
- Template-based Natural Language Question Generation with explicit requirements.

Template-based Natural Language Question Answering Generation

- Goal: Realistic benchmark questions that reflect real word requirements and constraints.
- Generated templates based on analysis of submissions related to recipe and diabetes made on the social media forum, Reddit (http://www.reddit.com/).

- Example: The following image shows an annotated user query from Reddit:

  - Based on the analysis, we identify the four common types of constraints:
    - positive ingredient constraints stating what ingredient(s) can be included in the recipe
    - negated ingredient constraints stating what ingredient(s) cannot be included.
    - nutrient-based constraints such as "low carb" or "high protein." and nutri
    - cuisine-based constraints such as "Indian," "Mexican.

- Queries feature a combination of these constraint types.
- Example Templates and the queries generated from them are shown in the table below:

<table>
<thead>
<tr>
<th>Template</th>
<th>Generated Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What are {tag} recipes that contain {in_list}?</td>
<td></td>
</tr>
<tr>
<td>2. What {tag} recipes can I cook without {in_list}?</td>
<td></td>
</tr>
<tr>
<td>3. Recommend {in_list} (optional) recipes which have {in_list}?</td>
<td></td>
</tr>
<tr>
<td>4. Recommend {in_list} recipes which have no {in_list}?</td>
<td></td>
</tr>
</tbody>
</table>

- We split the personalized KBQA benchmark dataset into training (4,621 examples), development (1,540 examples) and test sets (2,260 examples).

Model

- A personalized food recommendation system is supposed to take as input a natural language question, dietary preferences as well as health guidelines, and retrieve all recipes from a food KG that satisfy the requirements contained in the input.

- The overall architecture of our pFoodReQ framework is shown below:

References


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