Product Collection Recommendation in Online Retail

Motivation

- Behavioral data shows that users buy more than one product per transaction
- **Bundle recommendation**, i.e., recommending a set of products that can all be purchased together, is of benefit to sellers and buyers
- Oftentimes, the user is looking to buy a set of products that have **common** theme, e.g., bathroom remodeling

Problem Definition & High-level Approach

Collection recommendation problem: products belong to the same collection if they satisfy a set of constraints such as:

- Match Styles
- Constitute solutions for the same project
- Products are not interchangeable

Our Approach Combines:
- **Content information**, e.g. hierarchies, title, description
- **Transactional data**, e.g. co-purchases
- **Domain Knowledge**, e.g. collection relationships for a small number of products

Proposed Solution

**Step One**
Generate candidate sets of products that potentially belong to the same collection

**Product Level**
- Method 1 Using transactional data
- Method 2 Using domain knowledge

**Hierarchy Level**
- Shower Faucets
- Bathroom sink faucets
- Towel Bars

**Step Two**
Identify products from the candidate set that indeed belong to the same collection

- **BiLSTM**
- Embedding P1
- Concat
- Embedding P2
- Finally, we use cosine similarity to compute similar embeddings between products. Similar embeddings correspond to products that belong to the same collection.

Evaluation Set Up

**01 Competing methods**
- Collections from domain experts (Experts)
- Proposed Method 1 (Method1)
- Proposed Method 2 (Method2)

**02 Datasets**
- Bathroom: 487 anchor products
- Patio: 369 anchor products

**03 Evaluation process**
- For each anchor product, for each method, we generated 5 collection recommendations
- Used Home Depot’s validation team to validate whether each recommendation was relevant

Evaluation Results

<table>
<thead>
<tr>
<th>Method</th>
<th>Bath</th>
<th>Patio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>0.51 (0.32)</td>
<td>0.76 (0.23)</td>
</tr>
<tr>
<td>Method 1</td>
<td>0.75 (0.15)</td>
<td>0.83 (0.24)</td>
</tr>
<tr>
<td>Method 2</td>
<td>0.82 (0.13)</td>
<td>0.83 (0.24)</td>
</tr>
</tbody>
</table>

- Both proposed methods statistically significantly outperform the collections from experts
- For Bath, it is better to use domain knowledge to generate candidate sets while for Patio there is no difference in the two proposed methods

Discussion

Why collections from experts perform worse compared to the proposed?

**01 Collections involve products that are interchangeable**

**02 Collections involve products of the same brand only, while consumers do not shop this way**

E.g.: For BrandA (blue bar) 72% of the transactions involved 1 product from the same brand BrandA (i.e., all other products were of different brand)