Bundled Food (Meal) Recommendation

A Paper Review (MealRec: A Meal Recommendation Dataset)

Overview

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5. Category-Constrained Meal Recommendation
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Problem Statement

- Lack of high quality data for Meal Recommendation
- Other recommendation system not being category constrained
- Other category contrainsted RecSys does not include affiliation between dishes and a meal

Data Collection (Recipe)

- Recipe-User Interaction
  - Important representation about the food
  - Scraped from Allrecipes.com
  - Conditions:
    - Rating greater than or equal to 4
    - Commented on at least for 5 times
    - Users with positive Interaction with at least 5 recipes

30,833 recipes and 3,759,181 user-recipes

Data Collection

File name	Field	Description	Example
recipe.csv	recipe_id	recipe identifier	7994
	recipe_name	the name of the recipe	Coconut Poke Cake
	aver_rate	average user ratings(five-point scale)	4.634286
	image_url	the url of the recipe image	images.media-allrecipes.com/userphotos/720x405/334118.jpg
	category	the category the recipe belongs to in a meal	dessert
	ingredients	ingredients included in the recipe	white cake mix; cream of coconut; sweetened condensed milk; frozen whipped topping thawed; flaked coconut
	cooking_directions	food making process	Prep 30 m Cook 1 h Ready In 2 h Prepare and bake white cake mix according to package directions. Remove cake from oven...
	nutrition	nutritional content information of this food	sugars: {hasCompleteData: True, name: Sugars, amount: 36.66, percentDailyValue: 0, displayValue: 36.7, unit: g}, …
	review_num	total number of the recipe's reviews	756
	reviews	all reviews of the recipe	{2765483: {rating: 5, followersCount: 0, madeRecipesCount: 535, dateLastModified: 2009-11-29T07:46:22.803, text: Using the handle end of a wooden spoon perforates the cake better. This cake is incredible for days!, followingCount: 0}, ...
	tags	several tags selected by the creator represent features of the recipe	60-minutes-or-less; desserts;eggs-dairy; fruit; oven; potluck; picnic; cakes; nuts; eggs; dietary; coconut; to-go; equipment
user_recipe.csv	user_id	user identifier	168192
	recipe_id	recipe identifier	7994
	rating	user ratings for the recipe(five-point scale)	5
	dateLastModified	the time the user review was last modified	2014-04-25T14:54:20

Meal Construction

- Basic full-course meal: *appetizer*, *main dish*, *dessert*
- Explicit Features (creators' tags) and Implicit Features (*high calorie)*
- Conditions:
    - Both explicit and implicit of the meal need to be consistent
    - Recipes in meal should be enjoyed by a user over a period of time (guarantees the implicit features)

User-Meal Interaction Construction

- Usually bundles are gives lower tolerance (in music)
- Does not work good for food
- Consider that user likes a meal only if they like all the dishes in the meal

File Name	Field	Description
meal.csv	meal_id	meal identifier
	appetizer_id	recipe identifier of this appetizer
	main_dish_id	recipe identifier of this main dish
	dessert_id	recipe identifier of this dessert
user_meal.csv	user_id	user identifier
	meal_id	meal identifier

Category-Constrained Meal Recommendation: Data

- Users, Recipes, Meals and Category represented as U, R, M and C.
- Formulate affiliation relationship matrix between R and M as A.

	Appetizer	Main Dish	Dessert
Recipe 1	Recipe ID	Recipe ID	Recipe ID
Recipe 2	Recipe ID	Recipe ID	Recipe ID
Recipe 3	Recipe ID	Recipe ID	Recipe ID

- Formulate affiliation relationship matrix between R and C as G.

	Appetizer	Main Dish	Dessert
Recipe 1	1	0	1
Recipe 2	1	1	0
Recipe 3	0	1	1

Continued...

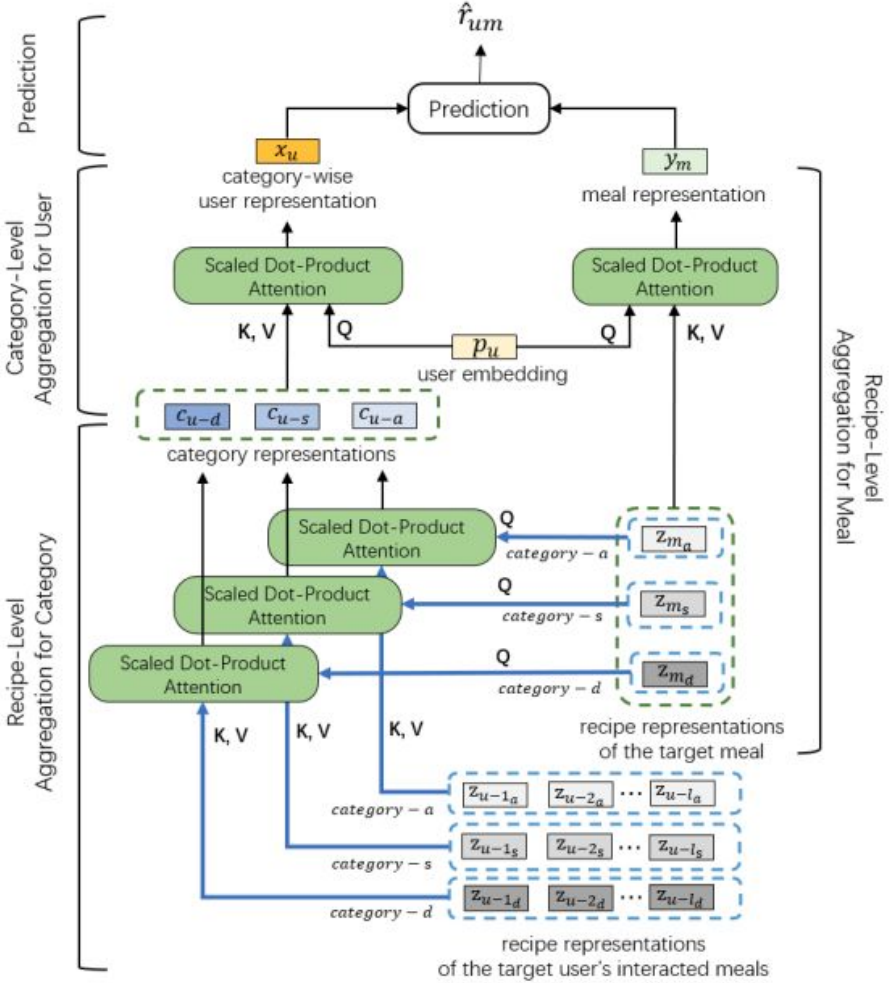
- Formulate affiliation relationship matrix between U and M as T.

	Meal 1	Meal 2	Meal 3
User 1	0	1	1
User 2	1	1	0
User 3	0	0	1

CCMR: Goal

- Given U, R, M, A, G and T, estimate preference of *u* to *m*.
- Estimate how much a user *u* prefers a meal *m*

CCMR: Model



fuse | machines

CCMR: Model

Meal Representation

- *Recipe Representation:*
  - Convert all recipes to embeddings as such
  - *z (recipe latent vector) = e (recipe embedding) + o (category embedding)*
  - Target user *u* also converted to latent space with user embedding represented by *p*
- *Recipe-Level Aggregation for Meal*

$$y_m = \text{Attention}(p_u, z_m, z_m) = \text{softmax}\left(\frac{p_u z_m^T}{\sqrt{d}}\right) z_m$$

CCMR: Model

Category-Wise User Representation

- Number of users' interacted meal is not same, so we set max number to *l*
- D is matrix if size |C| x *l* which is interactions of user will meals, where elements are recipe ID
- IDs converted to latent space vector using embeddings to generate *z*
- *Recipe-Level Aggregation for Category* (User's preference for a category)

$$c_{u_t} = \text{Attention}(z_{m_t}, z_{u_t}, z_{u_t}) = \text{softmax}\left(\frac{z_{m_t} z_{u_t}^T}{\sqrt{d}}\right) z_{u_t}$$

- *Category-Level Aggregation for User*

$$x_u = \text{Attention}(p_u, z_m, z_m) = \text{softmax}\left(\frac{p_u z_m^T}{\sqrt{d}}\right) z_m$$

CCMR: Recommendation

- Concatenate category-level aggregation for user (x), recipe-level aggregation for meal(y) and their dot product
- Feed that output to a three layered feed-forward network
- Final prediction is *r*, which can be used to rank candidate meals to provide top-k recommendations
- Loss function is Bayesian Personalized Ranking (BPR) Loss

$$Loss = \sum_{i=1}^{N} \sum_{s \in \mathcal{H}_i} \sum_{t \notin \mathcal{H}_i} -\ln \sigma \left(\hat{r}_{u_i m_s} - \hat{r}_{u_i m_t} \right) + \lambda \left\| \Theta \right\|_2^2$$

Applicability to this project

- Are there significant amount of recurring customer?
  - Can foods be bundled up into a meal? Are customers buying same bundles of food?
    - If yes, it might be worth trying out this approach.

THANK YOU !