toMEto: a Networks-based Approach to Recipe Recommendation

CS145

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ABSTRACT
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1. INTRODUCTION
Cooking is a

2. RELATED WORK
There have been a select number of papers discussing analysis of food and ingredient networks. Teng et al. describes the goal of being able to recommend entire recipes, using recipe suggestions made by examining communities of a co-occurrence network, to predict the success of a particular recipe's rating [4].

Another paper by Ahn et al. compares the differences in cuisine by instead looking at a flavor-compounds network, and making general statements about the co-occurrence of ingredients by their chemical composition [1]. They discovered that Asian recipes tend to have ingredients with different compounds, whereas Western cuisines have ingredients with like compounds.

Still other research is ongoing, some building upon the relevance of flavor compounds in regional cuisines [5], [3], and others attempt to implement these ideas to help users make suggestions about healthy food choices [2].

Within this web of research, we discovered a potential niche for recommending individual *ingredients*, as opposed to entire recipes. This combines both the practical application of current research on food networks, as well as the theory behind identifying ingredients thaFigure **??**t are compatible with each other.

3. DATA PROCESSING

4. ALGORITHM DESIGN AND ANALYSIS
The primary application of algorithm design resides in ingredient recommendation to the user. We reserve the majority of this section to understanding the different frameworks we tried for the *complement* method, which is a method that takes in a particular recipe ID, and suggests up to ten ingredients that the user could potentially add.

Before we do so, however, we first introduce some common terminology to be used throughout the text:

1. *w(x,y)* describes the weight of the edge between two ingredients.
2. *graph* is the entire ingredient network.
3. *peripheral ingredient* describes those ingredients that are not part of a recipe, but have at least one edge (with nonzero weight) to an ingredient in the recipe (Fig. 1). Formally, this is described as

$$\{k : \text{k} \in \text{adjacent neighbors of recipe} \land k \notin \text{recipe}\}$$

There are a two primary schools of thought when designing an appropriate algorithm for recipe recommendation - using degree centrality measures, versus using pointwise mutual information (PMI). Here we enumerate in detail the algorithms.

1. Degree Centrality (Fig. 1). This algorithm was the first variant that we attempted on ingredient recommendation.

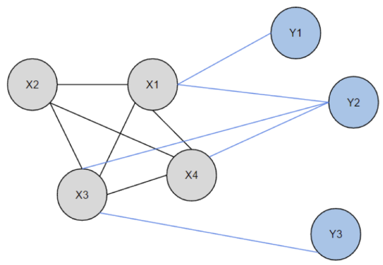


Figure 1: Peripheral ingredients

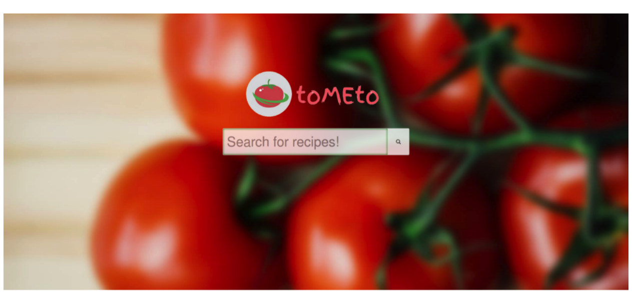
Algorithm 1 Degree Centrality algorithm

function NAIVE($recipeID$)
  Let $recipe$ = recipe with ID $recipeID$
  Let $top10$ = ten ingredients with highest weighted number of connections
  Let d = dictionary to contain all ingredients and their compatibility score
  for i in ingredients of $recipe$ **do**
    if i in graph and i not in $top10$ **then**
      for peripheral ingredient k **do**
        $d[k] = d[k] + \min(\frac{w(i,k)}{degree(i)}, \frac{w(i,k)}{degree(k)})$
  return 10 ingredients from d with highest compatibility score

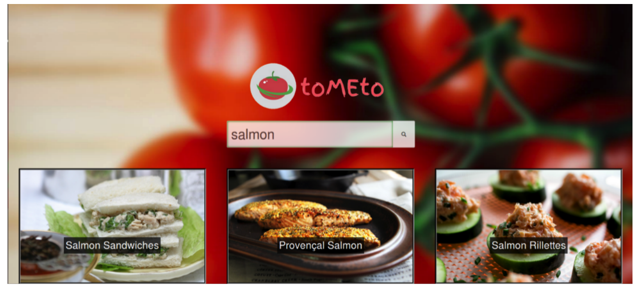
5. WEB DESIGN

Web design was done using a combination of HTML, CSS, JavaScript, and Python. HTML was used to create the content for display on the page, and CSS was used to style this content. JavaScript was also used for animations and general User Interface tweaks to make browsing the site intuitive and smooth. Finally, Python was utilized as an interface between the back-end and the front-end. Through the usage of Python's Flask framework, it was possible to integrate the back-end algorithms with displaying the relevant computed information on the front-end. In other words, our module app.py imported modules from the back-end, while also using this information to fill in the HTML templates based on search queries, etc. given by a user in the front end.

The primary focus on the front end was to develop a site that is intuitive and self-explanatory, while also featuring only the information that is needed the most. Thus, the landing page has the following design:



Upon searching for a recipe, a loading bar appears, and once recipe information ins obtained, tiles fade in. These tiles offer an image of the recipe to be prepared, with the recipe title overlaid on top. This can be seen below:

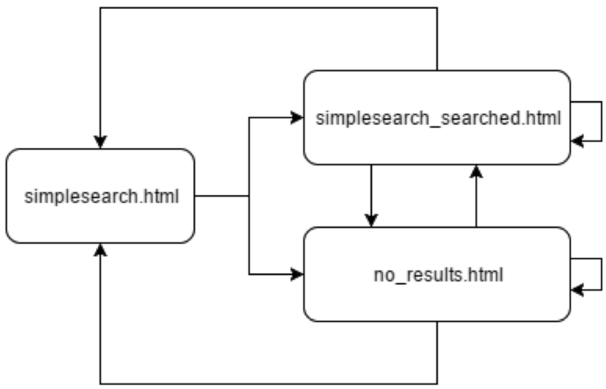


Upon clicking a recipe, a modal popup appears, which lists both the recipe itself as well as toMEto's recommended ingredients, as can be seen in the below image:

Much of the front-end was designed to be easily updated and maintained, and thus small UI tweaks, such as background images, color schemes, etc. are easily changeable by editing the HTML and/or CSS files. The front-end utilizes mainly three different HTML templates:

- simplesearch.html
- simplesearch_searched.html
- no_results.html

simplesearch.html is simply the html for the landing page, before any queries are entered. Then, once a search query is entered, app.py directs this information to the backend, which then generates information which is supplied to the simplesearch_searched.html template. The user is also redirected to this template, which includes the tiles, modal popup information, etc. Furthermore, if a search is entered into simplesearch_searched.html, this also refreshes the simplesearch_searched.html template, utilizing the new information. Finally, no_results.html is used as a template to be redirected to when the query entered into simplesearch.html or simplesearch_searched.html does not contain any results. As a note, a user will be redirected to simplesearch.html upon clicking the toMEto logo.



6. PERFORMANCE

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7. DISCUSSION

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8. CONCLUSIONS AND FUTURE WORK

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9. REFERENCES

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