Using ontologies for recipe image retrieval

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1. Abstract

There are a few searchable food recipe databases of a considerable size (for example RecipesDB that contains about a 100’000 recipes stored with multiple characteristics). This is not free to download and use but a plenty of limited online query option. The most used tool by a regular user is of course a regular search engine (Google, Bing, etc.) or directly within a cooking blog. The idea of how this works is simple: you have a list of filters and a main search word received as input. The result must be a list of consistent relevant results for those searched keywords. I will attempt to implement a system that uses ontologies in order to improve the retrieval capabilities of the search engine.

2. Introduction and related works

There are certain research studies that create an image retrieval system by integrating an extra layer of neurons on top of an already existing convolutional neural network trained for object detection or segmentation. This layer is dedicating to generating a more variate pallet of responses from a semantic perspective. Most image retrieval system rely on tag/labels and so will this system.

We will use an initial set of labels for each image and we will extend that with extra information (name, ingredients, subcategories, synonym for each of those). All these and the relationship between them will be stored using ontologies. This should also optimize the time of querying the databases. By processing with natural languages techniques we will find more solution similar to the initial query. For this we will be using wordnet, nltk, and owlready2. If a word slightly correlates with a certain recipe then that query should return the recipe.

3. Solution and Problem

The problem focuses on retrieving all the relevant recipes given a keyword. I make a supposition that the user has one of two intentions in mind. The user must either have a certain recipe in mind or he must have an approximate idea regarding what he looks for and chooses a keyword in consequence. The problem is represented by the process that should retrieve the list of recommended recipes.

In consequence the solution will be an information retrieval system for images that will use already correlated data regarding recipes and a multitude of other concepts like ingredients, categories, cooking steps, etc.

4. Application flow

The steps are simple after the user enters the app:

- The user writes a query consisting of one word in the search bar
- The search is initiated and the process is solved using the information retrieval system
- A list of relevant images of different recipes are returned and printed in the interface

As can be seen the interface will open with a search bar but also with an additional feature of filtering recipes (with or without images included). The images will be printed along with the recipe names (the first 30 of the found results). Some of the more relevant results will appear first while other might appear in the "More results" category.

5. Data and tools

Two main databases have been used for the project: im2recipe, foodb.

Im2recip is a simple dataset with 1 million entries scrapped from the internet. Each entry is one recipe containing the following relevant information for us:
- the name of the recipe/blog post

- the text representing the list of ingredients with much extra wordage

- the text representing the list of steps of preparation

This database contains an auxiliary dataset with image source link for some of the recipes which we will use in the process to make correlations to.

Foodb is a very complex database I used to extract the food ingredients. It contains a table of 1000 ingredients organized on categories and with many other details that could also be taken into account in the future. It also contains many other tables that describe the connections between food and nutrients or chemical compounds and even to health effects.

The main tools used in the project are:

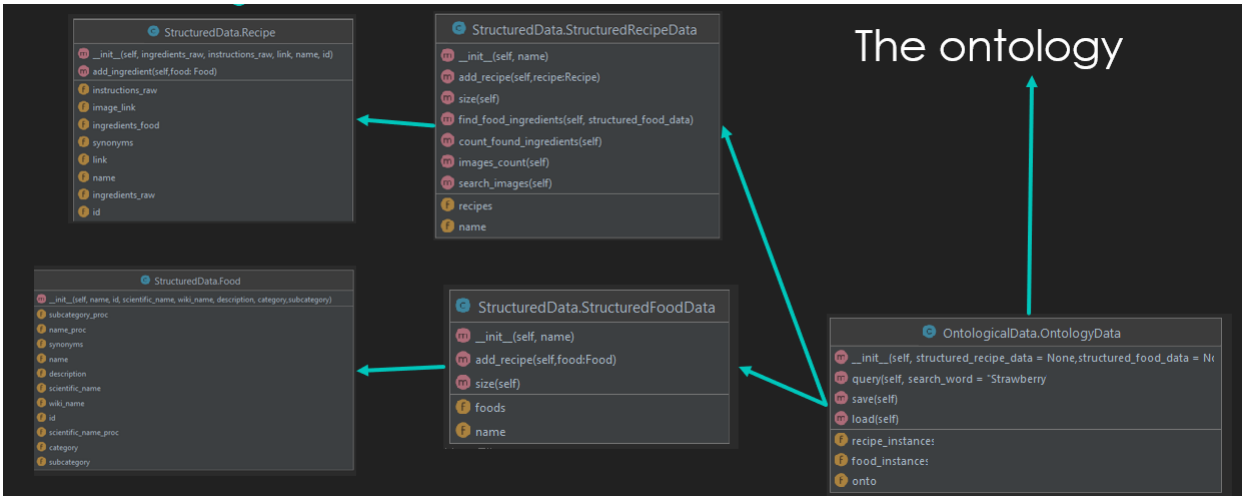
- Owlready2 which is a library that allows creation and simple querying of an ontology
- enchant for a simple function of the Levenshtein distance

- Wordnet used to find synonyms of word
- Nltk used to extract root of a word and semantic position
- Re used for basic string functions
- Requests used to download images
- Json, csv used to format management
- PIL, pysimplegui used for image operations and user interface construction

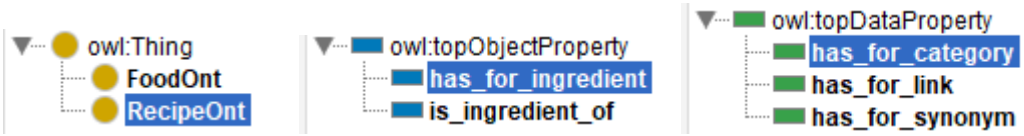
6. Algorithm and ontology

The process is constructed of two components: the information discovery algorithm and the querying service.

The first component will read both the databases (recipes and ingredients) pre-process the content (applying grammatical filter to extract the ingredient words from the raw text scrapped, find synonyms and copy categories onto the StructuredData classes as seen below). It will also look for images relevant to the recipes and save them too. In the end it will make correlations between the ingredients and the recipes, initiate the ontology structure, and populate it it with values and relationships.



The ontology has the following structure:



The second component deals with the querying. It will use the search function provided by the owlready2 library and a few additional verifications to find relevant recipes in this order: check mistakes, find recipe names with this word, search for recipes that contain a relanthionship with an ingredient that has that name (or similar), search for recipes that contain a relathionship with an ingredient that has a synonym relanthionship (or category) with a word like the keyword.

7. Conclusion

The experiment has been successful since a regular loading of the databases combined with the processing phase (not even counting querying) takes several hours and the ontology based solution can load and give results in just a couple seconds (maximum of a couple of minutes if using the entire recipe database of 1 million entries).

There are multiple extensions to the project available:

- Extending the number of attributes (adding different correlations to recipes: countries, cuisine)
- Extending the number of recipes (by scrapping)
- Adding medical information (inputting a list of ingredients and medical conditions and using the foodb + another database with medical conditions and treatments, return a list of possible recipes that could benefit for the conditions)