

CS 4395: Chatbot Project

a. System description and NLP techniques

This project is called BakeBot, a chatbot that converses with the user about baking. BakeBot can tell the user what recipes it knows as well as the tools needed to bake, specific ingredients like flour and sugar, how they are combined to make batter, and how long the batter should bake for. Its knowledge base was derived from a previous portfolio assignment where the blog of baker John Kanell of Preppy Kitchen (<https://preppykitchen.com/>) was crawled to find the most commonly used terms in baking recipes and examples of sentences associated with them. BakeBot is also trained with user inputs when the user expresses something that can be used for a personalized response (such as a like or dislike).

BakeBot was created using ChatterBot (<https://chatterbot.readthedocs.io/en/stable/#>), a Python library that implements machine learning algorithms to select the best response to a user input based on training lists of example conversations. ChatterBot is not currently being maintained which resulted in many dependency issues, so I used a previous version of ChatterBot that is compatible with spaCy. NLTK was used as well. The specific NLP techniques used are identified and described below:

- **WordNet:**
 - This was used to develop the user model as BakeBot converses with the user. Because there are various ways that the user can express a like/dislike, it was helpful to find the synonyms of the words “like” and “dislike”. The synonyms were found using WordNet’s synsets functionality and added to lists that could be used to detect when the user input an opinion that could be added to the user model.
- **Parsing user response**
 - The user’s inputs to the chatbot were parsed to pull out information that could be useful for adding details to the user model. The user’s input was tokenized and split into parts of speech via NLTK’s word_tokenize functionality. Being able to parse the user’s input enabled more specific analysis to be done on the input rather than to just generate an appropriate response.

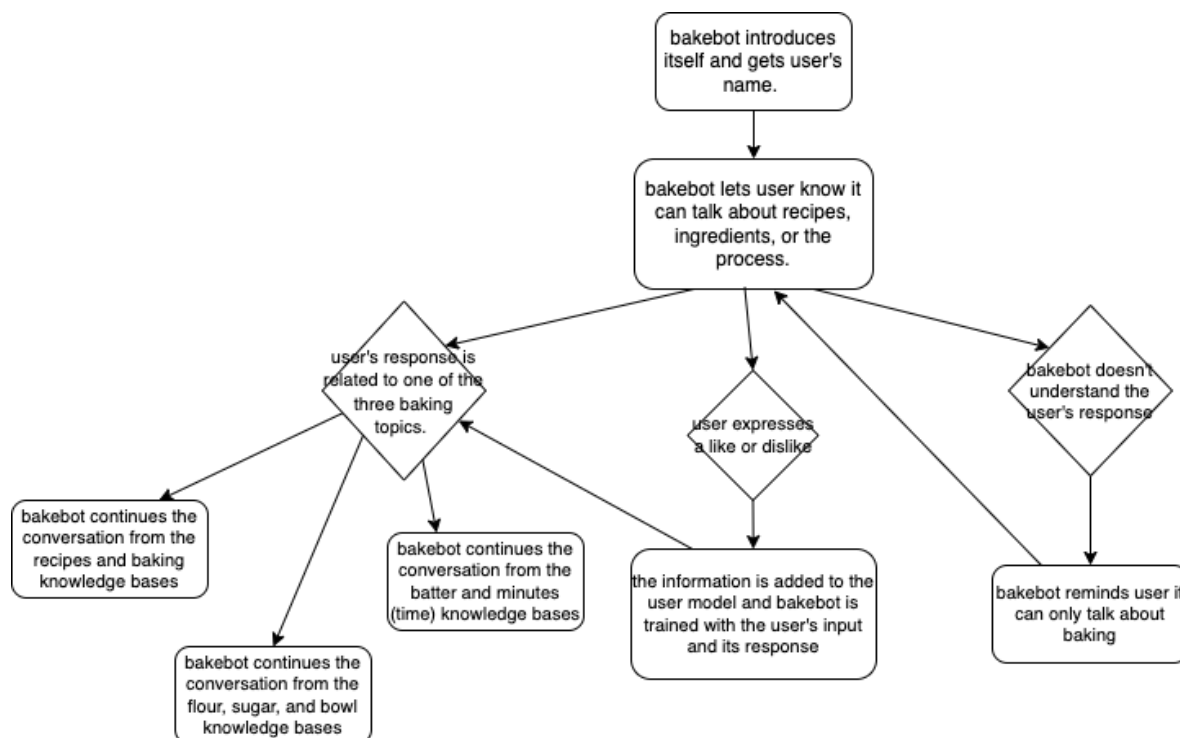
- Named Entity Recognition

- Named entity recognition was used to pull out the user's name specifically. At the start of the conversation, the chatbot asks the user for their name. There are a variety of ways the user could give the chat bot their name ("My name is...", "I am..." or just the name itself), so spaCy's named entity recognition functionality was used to detect which part of the input was a name. This allowed the user's name to be added to the user model no matter how the user input their name.

- Parts of speech tagging

- NLTK's parts of speech tagging was used to determine the important parts of a user input that could be added to the user model. If the user's input contained a word alluding to a like or dislike, the following nouns and verbs could be assumed to be what the user liked and disliked. This could only be determined via tagging the parts of speech. The specific nouns and verbs could then be added to the user model.

b. Diagram



c. Sample dialog interactions

```
you: hi bakebot
bakebot: i am bakebot. what's your name?
you: i am spongebon squarepants
bakebot: hello i am spongebon squarepants , let's talk about baking! i can tell you about recipes, ingredients,
you: i want to bake a cake
bakebot: try my lemon cake recipe, strawberry cake recipe, or naked cake recipe.
you: what about strawberry cake
bakebot: i only know about baking!
you: can i make a strawberry cake
bakebot: this vanilla cupcake recipe will blow your mind!
you: how do i make vanilla cupcakes
bakebot: question though, could i use this recipe to make a cake instead of cupcakes?
you: i do like cupcakes
List Trainer: [#####] 100%
bakebot: wait, you like cupcakes?
you: cupcakes are easy to make
bakebot: i only know about baking!
you: i like baking
List Trainer: [#####] 100%
bakebot: i want to bake.
you: me too, what should i bake
bakebot: i only know about baking!
you: what kinds of baking can i do
bakebot: if you want to kick start your fall baking, then make sure these pumpkin whoopie pies are on the top
you: bye
bakebot: bye i am spongebon squarepants !
```

```
you: hello bakebot
bakebot: i am bakebot. what's your name?
you: i am gary wood
bakebot: hello gary wood , let's talk about baking! i can tell you about recipes, ingredients, and the process.
you: i like baking cookies
List Trainer: [#####] 100%
List Trainer: [#####] 100%
bakebot: i want to bake.
you: me too, what do you like to bake
List Trainer: [#####] 100%
bakebot: there are many things to bake.
you: i want to bake a lemon cake
bakebot: there are many things to bake.
you: we should bake from scratch
bakebot: i only know about baking!
you: do we need flour?
bakebot: in another mixing bowl, whisk together the pumpkin puree, sugar, oil, eggs, and vanilla, until well combined
you: what kind of sugar do we need?
bakebot: with the mixer on low speed, gradually mix in the sugar, about ¼ a cup at a time, alternating with a tablespoon
you: does the batter need to chill?
bakebot: i only know about baking!
you: how long do we chill the batter
bakebot: so, it's best to use unsalted butter and then add salt to the batter.
you: do we use ramekins
bakebot: you can prepare the batter ahead of time.
you: how do i mix the batter
bakebot: so, it's best to use unsalted butter and then add salt to the batter.
you: can i add strawberries
bakebot: if your strawberries aren't very flavorful or you'd like a stronger strawberry taste, you can add up to 1 teaspoon
you: thank you
bakebot: happy baking!
you: bye
bakebot: bye gary wood !
```

```
you: hello
bakebot: i am bakebot. what's your name?
you: i am suzie sue
bakebot: hello i am suzie sue , let's talk about baking! i can tell you about recipes, ingredients, and the process.
you: what is a good recipe?
bakebot: whether you are looking for a stunning red cake for valentine's day or just need a showstopping cake for birthdays, holidays, or any other
you: how do i make the batter for the red cake?
bakebot: this vanilla cupcake recipe will blow your mind!
you: how do i make the cupcakes?
bakebot: the batter is simple.
you: what do i mix into the batter?
bakebot: so, it's best to use unsalted butter and then add salt to the batter.
you: is there flour in the bowl as well?
bakebot: scrape down the bowl.
you: how long do i bake the batter for?
bakebot: it takes a bit of time to bake.
you: does it take a lot of time?
bakebot: divide the batter among three buttered 6-inch pans and bake for about 30 to 35 minutes or until the centers are springy to the touch.
you: thank you
bakebot: happy baking!
you: bye
bakebot: bye i am suzie sue !
```

d. Appendix: Knowledge base with samples

The knowledge base for this chatbot was derived from the web-crawler portfolio assignment. For that assignment, I crawled through the website of John Kannell of Preppy Kitchen, which has many recipes specially for desserts and baking. Some of the top terms were recipe, baking, sugar, bowl, minutes, and batter, which were added to a dictionary with the values being the sentences containing the words. Samples for baking and batter are below.

The knowledge base was used to train the chatbot via the `train()` method in the ChatterBot library. The method takes a list of sentences where each sentence is a possible response to the sentences before it. Because the chatbot mainly gives tips and information rather than executing a question-and-answer based interaction, the order of the sentences could mainly be left as they were from the web-crawler. Some broad introductory phrases were added at the beginning of each segment of the knowledge base to help guide the conversation, however.

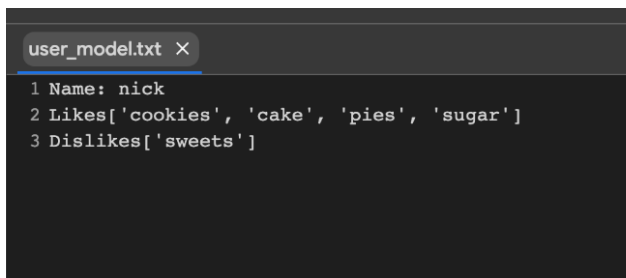
```
how do i bake?  
  
there are several steps to baking.  
  
bring the ramekins to room temperature before baking.  
  
once the apple cobbler has reached room temperature, you can cover the baking dish and transfer it to the fridge for up to 5 days.  
  
in a large bowl, whisk together the flour, baking powder, salt, and baking soda.  
  
defrost the frozen treats in the fridge overnight, then let them come to room temperature before serving.  
  
i do not recommend chilling this cookie dough before baking.  
  
tell us which cookies you're baking!  
  
if you want to kick start your fall baking, then make sure these pumpkin whoopie pies are on the top of your list!  
  
using a small ice cream scoop (about 2 tablespoons), scoop the dough onto the lined baking sheets about 1 inch apart.
```

```
how do i make the batter?  
  
the batter is simple.  
  
what do i mix in the batter?  
  
so, it's best to use unsalted butter and then add salt to the batter.  
  
make sure you take them out ahead of time as they will incorporate into the batter better when at room temperature.  
  
transfer the batter into buttered and floured ramekins.  
  
you can prepare the batter ahead of time.  
  
you can prepare the batter, cover tightly, and refrigerate the filled ramekins for up to 2 days.  
  
whisk batter together until smooth.  
  
adding strawberries directly into the batter or frosting does not incorporate the strawberry flavor throughout the cake, and just pureeing strawberries adds too m  
  
if your strawberries aren't very flavorful or you'd like a stronger strawberry taste, you can add up to 1 teaspoon of strawberry extract to the cake batter and fr
```

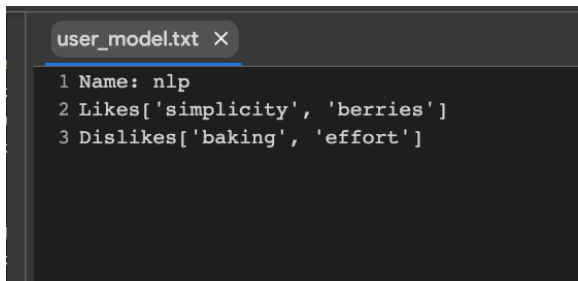
e. Appendix: Sample user models

Because the chat bot doesn't operate in a question-and-answer style, the user model is not necessarily used to guide the conversation. Rather, it is used to pick up the conversation when the chatbot doesn't have a high degree of confidence in its response to a given input. The user's name is also used to personalize the greetings at the beginning and end of the conversation.

When the user says they like or dislike a particular thing or action, it is saved as part of the user model. When the chatbot runs into an input where its response has a low confidence, it defaults to asking about one of the user's likes or dislikes. This helps the chatbot continue the conversation and guide them away from topics the chatbot isn't well-versed in. Therefore, the user models simply contain the user's name, likes and dislikes. This enables personalization in the conversation despite the chatbot mainly providing information as opposed to a question-and-answer interaction.



```
user_model.txt X
1 Name: nick
2 Likes['cookies', 'cake', 'pies', 'sugar']
3 Dislikes['sweets']
```



```
user_model.txt X
1 Name: nlp
2 Likes['simplicity', 'berries']
3 Dislikes['baking', 'effort']
```

f. Evaluation, strengths and weaknesses

The chatbot does an overall decent job at providing the user with responses that consider the user's input and make sense. The separation of the knowledge base into different topics and the ability for the chatbot to learn based on specific example conversations helped with this. It also helps if the user knows what the knowledge base looks like so they can help the chatbot guide the conversation. However, consideration of the knowledge base on the user's part is not ideal. The chatbot could definitely be

improved by expanding the knowledge base to provide more robust greetings and small talk type conversations, as well as expanding the knowledge base of the baking topic itself. This means that more varied inputs from the user would result in just as coherent results from the chat bot.

The personalization piece could be improved as well. It might be useful to build up the small-talk part so the chatbot can get more specific information from the user outside of likes and dislikes. This might make the chatbot more question-and-answer based, though. Right now, one strength of the chatbot is that it takes what the user says and gives them more information on topics it picks up without requiring specific formatting on the user's end.

The chatbot should also be able to handle more varied inputs. The current chatbot operates completely in lowercase to assist with parsing and matching words to various lists. It would be helpful for it to also be able to interpret user inputs even if typos are made, and perhaps even handle special characters that may be input as well.

BakeBot still has a long way to go to become a chatbot that can truly handle a robust conversation, but it has a good start for now.