The Food Court

Software Documentation

Database Systems Course (2018-2019) – Final Project

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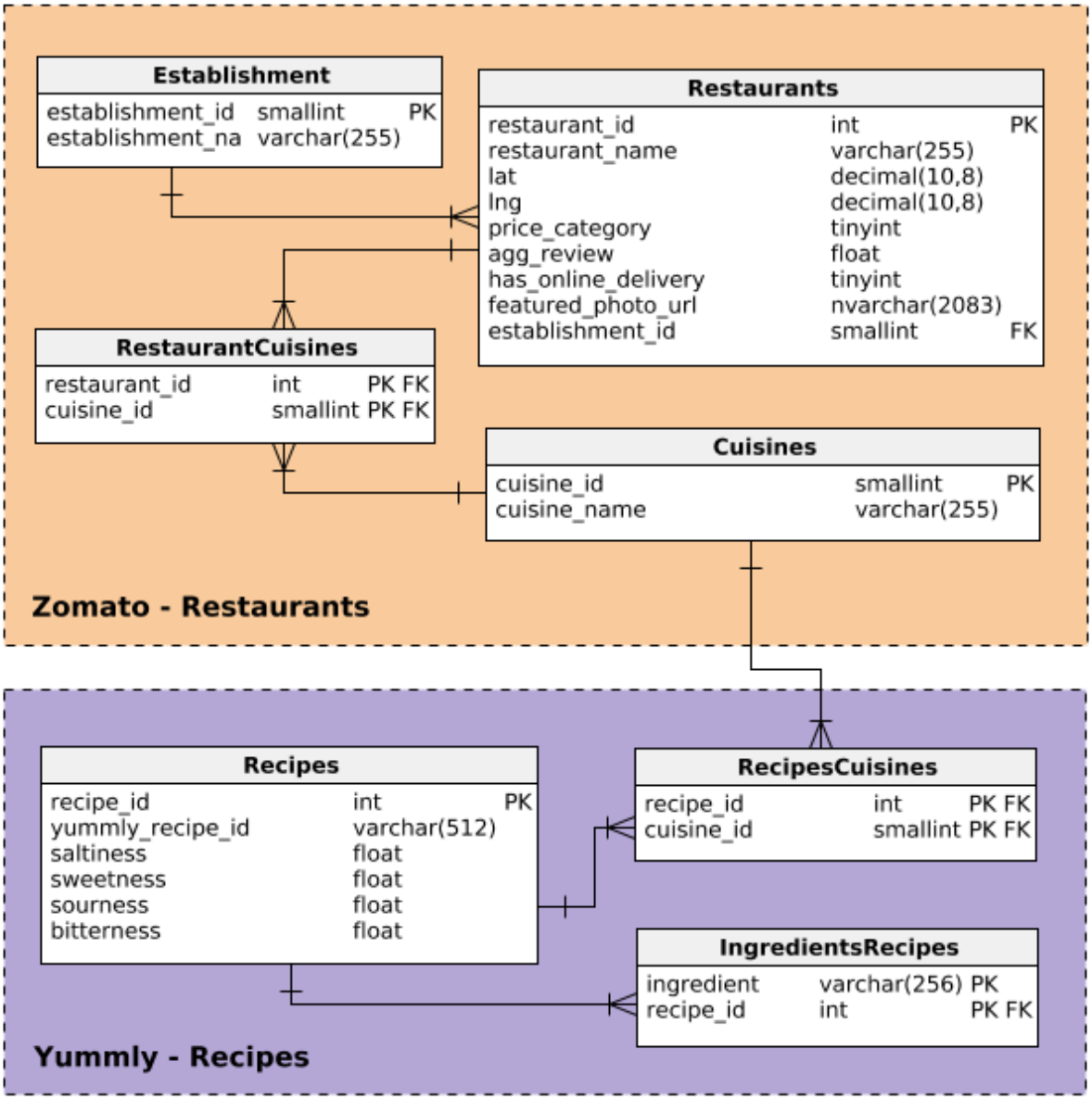
DB Scheme structure

DB Scheme:



For more details, see `CREATE-DB-SCRIPTS.sql`.

Number of rows per table:

Table Name	Establishments	Restaurants	RestaurantsCuisines	Cuisines	Recipes	RecipesCuisines	IngredientsRecipes
# rows	34	10,691	19,246	138	18,734	21,042	164,127

The design choice of our database was inspired by both the APIs we used ("Zomato", "Yummly") and our website's design and purpose. As seen in the above image (of the DB scheme), we can split our tables into two parts, one for each API. The two parts are connected through the **`Cuisines`** table. To make sure that the table values (which are populated from the "Zomato" API) match, during our database population we have created a translation map to translate values of cuisine names between "Zomato" and "Yummly". We will shortly describe each table design choices:

`Restaurants`: Each row in this table is a projection of values in the "Zomato" API restaurants tables. Only relevant columns for our website were stored in our database. We used "Zomato's" restaurant_id as our key. This enables us to find the restaurant easily (if needed in the future) in the "Zomato" API, without storing another column. The featured photo URL is bound by size to the maximum size of URLs in Microsoft's Internet Explorer.

`Establishments`: The table is identical to the establishments table in "Zomato" API. Each restaurant has an establishment_id associated with it.

`Cuisines`: The table is identical to the cuisines table in the "Zomato" API. Each restaurant can have multiple cuisine types, and therefore we use the following table to capture that relation.

`RestaurantsCuisines`: Used to connect between restaurants and their corresponding cuisines.

`Recipes`: Each row here is a projection of values in the "Yummly" API recipes tables. Since "Yummly" use an identifier which is a string (the recipe name), which might be long, we have added an AUTO INCREMENT id column as a primary key for each recipe. This is the primary key that is also linked in the following table. This allows us for faster search (small int value instead of long strings) and saves storage space.

`IngredientsRecipes`: From each "Yummly" recipe, we extract its ingredients and save them up in this table. Since ingredients can appear multiple times in the table, as well as each recipe, the primary key is a tuple of both.

`RecipesCuisines`: Used to connect between recipes and their cuisines. The cuisine data is stored in each recipe in the "Yummly" API, and we use the translation map mentioned above to match it to the relevant row in the **`Cuisines`** table.

DB Optimizations Performed

Indexes:

When designing the table and its indexes, we used one main assumption as a guidline:

All online queries (queries performed by clients) are `SELECT` queries, and not `INSERT` or `UPDATE` queries.

This key assumption was crucial to our index choice. Since each added index increases insert and update time (due to modification needed after the query to update the index), the assumption above enabled us to add indexes without impacting online performance in terms of query time. We did keep in mind that still, indexes needed to be loaded into memory, thus we still needed to pick our indexes intelligently.

The indexes mentioned below are additional indexes to those created automatically for primary keys. Those are not mentioned here.

- **`flavor_index:`** the index improves query performance for the `` `restaurant_by_taste` `` query (see next chapter). The index is composed of four columns – the exact ones used in the query. Since the query searches up ranges of flavors (e.g. `` `sweetness BETWEEN X AND Y` ``) we used a BTREE index.
- **`restaurant_location_index:`** the index improves query performance for all restaurant queries using location filtering. We used a normal BTREE index (and not SPATIAL), since our location filtering for restaurant is simple – a square search around a given location, only needing range querying for the `lat,lng` columns, and not complex geometric queries.
- **`restaurant_review_index:`** the simple index is used to optimize restaurant filtering by user's review averages (the `agg_review` column). Since the query is using comparisons (e.g. `` `greater than` `` we used a BTREE for this index as well.
- **`restaurant_price_index:`** similar to the above, but for the `price_category` column

We have also considered a hash index over the **`ingredient`** column in the **`IngredientsRecipes`** table, in order to optimize queries that look up for a specific ingredient value. However, considering the existing BTREE index over this column, the size of the table and the time the queries take without adding the index, we have decided that the index does not justify the added memory usage of it.

Queries

We list below the main query our application uses. Some queries are not mentioned here, but can be viewed in the **sql_queries.py** python script. These queries are small queries with mainly functionality which is transparent to the users. For each query below we show the SQL query code, we describe the query and show sample results.

1: Restaurant Query Wrapper

```
SELECT restaurant_name,
       lat,
       lng,
       price_category,
       agg_review,
       has_online_delivery,
       featured_photo_url,
       establishments.establishment_id,
       establishment_name
FROM   establishments,
       (%s) AS source
WHERE  establishments.establishment_id = source.establishment_id
AND    %f <= source.lat
AND    source.lat <= %f
AND    %f <= source.lng
AND    source.lng <= %f
AND    source.price_category = %s
AND    source.agg_review >= %s
AND    source.has_online_delivery = %s
AND    source.establishment_id = %s
```

This query is a modular query used to wrap queries that return restaurant values. The input query is added as the **(%s)** with alias **source**. Each **AND** condition is added only if the filtering condition is added. The query adds the establishment name to the restaurant from the **Establishments** table. The modularity is added through the **restaurant_query_builder** function in the **db.py** python file.

Example result:

```
"Dunkin Donuts"  "40.71504167"    "-74.00769167"   "2"      "3"      "0"
        "https://b.zmtcdn.com/data/res_imagery/16758439_CHAIN_212347c0633d3b3c9b006a875bd28882_c.png"  "281"
        "Fast Food"
```

2: Discover new cuisines from cuisine

```
SELECT   cuisinetocuisine.cuisine_id,
         cuisinetocuisine.cuisine_name,
         ( cuisinefreq / cuisine_receipe_count.receipe_weight ) AS match_value
FROM     (
                  SELECT    cuisines.cuisine_id,
                            cuisines.cuisine_name,
                            Count(cuisines.cuisine_id) AS cuisinefreq
                  FROM      (
                                      SELECT    ingredient,
                                                Count(ingredient) AS maxingredients
                                      FROM      cuisines
                                      LEFT JOIN recipescuisines
                                      ON        cuisines.cuisine_id = recipescuisines.cuisine_id
                                      LEFT JOIN ingredientsrecipes
                                      ON        recipescuisines.recipe_id = ingredientsrecipes.recipe_id
                                      WHERE     cuisines.cuisine_id = %s
                                      GROUP BY  ingredientsrecipes.ingredient) AS commoningredients
                  LEFT JOIN ingredientsrecipes
                  ON        commoningredients.ingredient = ingredientsrecipes.ingredient
                  LEFT JOIN recipescuisines
                  ON        ingredientsrecipes.recipe_id = recipescuisines.recipe_id
                  LEFT JOIN cuisines
                  ON        recipescuisines.cuisine_id = cuisines.cuisine_id
                  WHERE     cuisines.cuisine_id <> %s
                  GROUP BY  cuisines.cuisine_id) AS cuisinetocuisine,
         (
                  SELECT   cuisine_id,
                           count(cuisine_id) AS receipe_weight
                  FROM     recipescuisines
                  GROUP BY cuisine_id) AS cuisine_receipe_count
WHERE    cuisine_receipe_count.cuisine_id = cuisinetocuisine.cuisine_id
ORDER BY match_value DESC limit 3
```

This query, given a cuisine (**`cuisine_id`**), finds new cuisines (i.e. cuisines which are not the input cuisine) which share the greatest number of ingredients for which the cuisines' recipes have. Because some cuisines might have more recipes than other cuisines, we normalize the results with the number of recipes each cuisine has, and calculate it as a **`match_value`**. We return the top three matching cuisine with the highest **`match_value`**. The results of the query are cached in a cache mechanism we implemented in the backend (see "Code Structure" section for more details).

Example result, given input cuisine "Greek" (**`cuisine_id = 45`**):

cuisine_id	cuisine_name	match_value
70	Mediterranean	9.4146
147	Moroccan	8.8618
491	Cajun	8.1741

.

3: Query restaurants by ingredients

```
SELECT restaurants.*
FROM   restaurants,
       restaurantscuisines,
       (SELECT recipescuisines.cuisine_id
        FROM   ingredientsrecipes,
               recipescuisines,
               cuisines,
               (SELECT cuisine_id,
                       Count(recipe_id) cuisine_recipe_cnt
                FROM   recipescuisines
                GROUP  BY cuisine_id) AS CuisineRecipesCount
        WHERE  recipescuisines.recipe_id = ingredientsrecipes.recipe_id
               AND ingredientsrecipes.ingredient = '%s'
               AND CuisineRecipesCount.cuisine_id = recipescuisines.cuisine_id
        GROUP  BY recipescuisines.cuisine_id
        ORDER  BY Count(recipescuisines.cuisine_id) / cuisine_recipe_cnt DESC
        LIMIT  3) AS CuisinesByIngredient
WHERE  restaurantscuisines.cuisine_id = CuisinesByIngredient.cuisine_id
       AND restaurants.restaurant_id = restaurantscuisines.restaurant_id
```

Given an ingredient (queried before from the **IngredientsRecipes** table), this query returns restaurants which cuisine types match the top 3 cuisines that are linked to the given input ingredient, adjusted by weight (as in the previous query) of the number of recipes for each cuisine. This query is then wrapped with the restaurant query wrapper (query 1).

Example result, given input ingredient “shimeji mushrooms”:

```
"16766735"  "Ginza Japanese Restaurant"   "40.59290833"     "-73.95017222"
      "3"   "3.7" "0"   ""    "21"
```

4: Query restaurants by taste

```
SELECT restaurants.*
FROM   restaurants,
       restaurantscuisines,
       (
              SELECT cuisine_id
              FROM   (
                              SELECT   recipescuisines.cuisine_id,
                                       (Count(recipescuisines.cuisine_id)/cnt) AS weight
                              FROM     recipes,
                                       recipescuisines,
                                       (
                                                SELECT   recipescuisines.cuisine_id,
                                                         Count(recipescuisines.cuisine_id) AS cnt
                                                FROM     recipes,
                                                         recipescuisines
                                                WHERE    recipes.recipe_id = recipescuisines.recipe_id
                                                GROUP BY recipescuisines.cuisine_id ) AS numrecipespercuisine
                              WHERE    saltiness BETWEEN %s
                              AND      sweetness BETWEEN %s
                              AND      sourness BETWEEN %s
                              AND      bitterness BETWEEN %s
                              AND      recipescuisines.recipe_id = recipes.recipe_id
                              AND      recipescuisines.cuisine_id = numrecipespercuisine.cuisine_id
                              GROUP BY recipescuisines.cuisine_id
                              ORDER BY weight DESC) AS matchingtastes
              WHERE  NOT EXISTS
                     (
                            SELECT *
                            FROM   (
                                           SELECT   recipescuisines.cuisine_id,
                                                    (count(recipescuisines.cuisine_id)/cnt) AS weight
                                           FROM     recipes,
                                                    recipescuisines,
                                                    (
                                                             SELECT   recipescuisines.cuisine_id,
                                                                      count(recipescuisines.cuisine_id) AS cnt
                                                             FROM     recipes,
                                                                      recipescuisines
                                                             WHERE    recipes.recipe_id = recipescuisines.recipe_id
                                                             GROUP BY recipescuisines.cuisine_id ) AS numrecipespercuisine
                                           WHERE    saltiness BETWEEN %s
                                           AND      sweetness BETWEEN %s
                                           AND      sourness BETWEEN %s
                                           AND      bitterness BETWEEN %s
                                           AND      recipescuisines.recipe_id = recipes.recipe_id
                                           AND      recipescuisines.cuisine_id = numrecipespercuisine.cuisine_id
                                           GROUP BY recipescuisines.cuisine_id
                                           ORDER BY weight DESC limit 5) AS notmatchingtastes
                            WHERE  matchingtastes.cuisine_id = notmatchingtastes.cuisine_id ) limit 3) AS cuisinesbytaste
WHERE  restaurants.restaurant_id = restaurantscuisines.restaurant_id
AND    restaurantscuisines.cuisine_id = cuisinesbytaste.cuisine_id
```

Similar to the third query, this query returns restaurants as well. However, here the input are the user's flavors preferences (i.e. whether he likes/dislikes salt/sweet/sour/bitter food). This query searches for the cuisines that matches the user's tastes, but also don't match the tastes opposite of the user's. This is done by filtering out such cuisines. All of the values are weighted as well (similar to the above queries) to account for cuisines with high/low number of recipes. Finally, this query can be then wrapped by the restaurant query wrapper.

Example result, given input (dislike salty food, likes sweet food, dislikes sour food, dislikes bitter food):

```
"16761060"  "Bouchon Bakery & Cafe" "40.76841410"     "-73.98270370"     "4"
      "4.3" "0"
      "https://b.zmtcdn.com/data/res_imagery/16761060_RESTAURANT_ce0cc676161
eedd94d28f01a5007a958_c.jpg"  "1"
```

5: Find unique ingredients of cuisine

```
SELECT *
FROM   (
                SELECT   ingredient,
                         Count(ingredient)
                FROM     ingredientsrecipes,
                         recipescuisines
                WHERE    ingredientsrecipes.recipe_id = recipescuisines.recipe_id
                AND      recipescuisines.cuisine_id = %d
                GROUP BY ingredient
                ORDER BY count(ingredient) DESC) AS ingredientsofcuisine
WHERE  NOT EXISTS
       (
              SELECT *
              FROM   (
                              SELECT   ingredient
                              FROM     ingredientsrecipes,
                                       recipescuisines
                              WHERE    ingredientsrecipes.recipe_id = recipescuisines.recipe_id
                              AND      recipescuisines.cuisine_id <> %d
                              GROUP BY ingredient
                              ORDER BY count(ingredient) DESC limit %d) AS ingredientsofothercuisines
              WHERE  ingredientsofothercuisines.ingredient = ingredientsofcuisine.ingredient ) limit 10
```

Given an input cuisine, this query finds the top ingredients that are both common for that cuisine, but are not common in general (thus, are associated with the cuisine). The query, after ordering the ingredients by how they are common for that cuisine, filters out the most common ingredients of cuisines which are not the input cuisine. If the query with high value of filtering doesn't return a value, the backend server automatically performs a second query with a smaller number of filtering. This query results, similar to query number 2, are cached in the backend server (see "Code Structure" section).

Example result, given input "Greek cuisine" (**`cuisine_id = 156`**):

ingredient	Count(ingredient)
feta	26
dill	22
pitted kalamata olives	20
greek seasoning	14
ground lamb	12
hummus	11
phyllo dough	9
crumbled feta	9
chopped fresh mint	8
roasted red peppers	8

.

6: Optimal franchise to open query

```
SELECT restaurant_name
FROM   (SELECT restaurants.*,
               restaurantscuisines.cuisine_id
        FROM   restaurants,
               restaurantscuisines
        WHERE  EXISTS (SELECT *
                       FROM   (SELECT *
                               FROM   (SELECT restaurant_name
                                       FROM   restaurants
                                       GROUP  BY restaurant_name
                                       HAVING Count(restaurant_name) > 10) AS
                                      Franchises
                               WHERE  NOT EXISTS (SELECT *
                                                  FROM   (SELECT restaurant_name
                                                          FROM   restaurants
                                                          WHERE
                                                      lat BETWEEN %f AND %f
                                                      AND lng BETWEEN %f AND
                                                          %f) AS
                                                         LocationRestaurants
                                                  WHERE
                                              Franchises.restaurant_name =
       LocationRestaurants.restaurant_name))
       AS
       FranchisesNotInLocation
       WHERE  restaurants.restaurant_name =
       FranchisesNotInLocation.restaurant_name)
       AND restaurants.restaurant_id = restaurantscuisines.restaurant_id) AS
       OptionalFranchises
WHERE  NOT EXISTS (SELECT *
                   FROM   (SELECT cuisine_id
                           FROM   restaurants,
                                  restaurantscuisines
                           WHERE  lat BETWEEN %f AND %f
                                  AND lng BETWEEN %f AND %f
                                  AND restaurants.restaurant_id =
                                      restaurantscuisines.restaurant_id
                           GROUP  BY cuisine_id
                           ORDER  BY Count(cuisine_id) DESC
                           LIMIT  15) AS CuisinesInLocation
                   WHERE  CuisinesInLocation.cuisine_id =
                          OptionalFranchises.cuisine_id)
GROUP  BY restaurant_name
```

This unique query, given a location (**`lat,lng`**) gives suggestion on which franchises should be opened in that location in order to maximize success. First, franchises are defined by restaurants for which there are more than 10 branches of. The query searches for franchises that are not already existing with a certain L1 distance from the given location (to avoid opening two McDonald's in the same location for example), and then filters out franchises that cuisine type is one of the top 15 cuisine types in that location (so the new franchise will give a new value).

Example result, given input "Times Square Location" (**`lat: 40.758899, lng: -73.9873197`**):

Restaurant_name
Kennedy Fried Chicken
Golden Krust
Taco Bell

.

7: Find common ingredients with a given ingredient

```
SELECT   ingredient,
         Count(ingredient)
FROM     recipes,
         ingredientsrecipes
WHERE    recipes.recipe_id = ingredientsrecipes.recipe_id
AND      EXISTS
         (
                SELECT re.recipe_id
                FROM   recipes            AS re,
                       ingredientsrecipes AS ir
                WHERE  ir.ingredient = %s
                AND    re.recipe_id = ir.recipe_id
                AND    recipes.recipe_id = re.recipe_id)
AND      ingredientsrecipes.ingredient <> %s
GROUP BY ingredient
ORDER BY count(ingredient) DESC limit 10
```

Given an input ingredient, this query finds the ingredients that appear the most in recipes where the input ingredient is used. The query returns the 10 most common ingredients. This allows users who want to make recipes with their favorite ingredient to know which ingredient usually appears with it, so they can stock them to maximize recipe options!

Example result, given input "tequila":

ingredient	Count(ingredient)
lime juice	32
salt	31
lime	25
triple sec	21
olive oil	17
fresh lime juice	13
jalapeno	12
agave nectar	11
limes	11
ice	11

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Code Structure

Our code is split in to three parts: DB Population scripts, Frontend and Backend. We will describe in short the structure of each part:

DB Population Scripts [Python, MySQL]:

DB Population scripts are simple standalone python scripts. There are two main scripts – one for the "Zomato" API and one for the "Yummly" API. Each script was created to match the services given by the relevant API. The connection to the API is done using GET requests through the `requests` python library. We use json and sometimes decoding to process the values we get from the API and then `MySQLdb` to store the values in our databases.

Frontend [HTML, CSS, JS]:

The frontend is comprised from two parts. The first one is the JavaScript controller file, and the second one is the HTML web page.

Our site contains a single HTML page: 'TheFoodCourt.html', which contains the site's core layout and the DOMs (Document Object Models) that are bound to the site's controller. The visual components on the site were built by using both HTML's basic tags and CSS.

'fcController.js' is the controller attached to our site. It binds our application data to the attributes of the HTML DOM elements. Its functions are invoked by the site's input forms and button click events. Then, it gets the required data from the backend: the data retrieval is done by using Fetch API (an API which provides a generic Request and Response objects). Finally, the retrieved data is displayed to the user by updating the HTML page asynchronously (using angular). We have also introduced one special functionality as well:

1. **Interactive Map** – we use the 'MapBox' API to incorporate an interactive map in our website. The map allows scrolling and zooming and supports two main functionalities: the first one being a medium for displaying restaurant results (which can be displayed on the map if the user chooses to), and the second one as an interface for location based querying which allows the user to engage with the query in an additional way. We believe that the map adds a unique value to the website's visuals and functionality, and help engage its users.

Backend [Python, Flask, MySQL]:

The backend is comprised from two parts. The first one is our database – a MySQL database on the university servers. The second is comprised from the backend server. Our backend server is made up of a few python scripts. The main one being the `server.py` script which has all the "server" functionality (all the Flask functionality). Each query against the database is done through the "db.py" file, which is managed by a class we have created so there is only one cursor working with the server at any given time. All the queries that include user input are protected against invalid inputs, especially SQL injection – either by the cursor exposed functionality of the MySQLdb library, or by checks that we apply when the integration of the user input is done before the query. The SQL queries themselves are stored in another python script – 'sql_queries.py'. We have introduced two special functionalities to the server as well:

1. **Caching** – some queries are cached. This means that when the query first executes, we store the result in memory, and make it valid for 24 hours. Therefore, if at any time in these 24 hours the same query is requested, we get the value immediately from the memory instead of running it through the database. This allows for much faster execution time, and reduces load on our database. The queries which are cached are chosen carefully, and only queries which have high probability to reoccur are cached. This is done to prevent saving a lot of query results in memory, since this won't be efficient. We have decided ono a timed cache since user experience won't be affected if the result of these queries will be "outdated" by at most a day. Even if there was an update to the relevant tables in that 24 hour period, most of the time the query results won't change, and if they do – they won't change significantly. Therefore, limiting the cache persistence to 24 hours was a good balance between not using a cache and using a cache that is updated every time the source tables are updated.
2. **Logging** – we use a logging system to log every request by users and errors. Each exception that occurs during the server run is stored as an error with the exception value and the location where it happened. This is true for faulty SQL queries as well. As stated, apart from the errors, we also store every user generated request to the server. This allows later to analyze usage and create statistics of popular (and unpopular) functionalities and more, to improve the website in terms of usability, reach and performance. The error logs can help detect bugs and unexpected or unpredicted user interactions, which will help reduce bugs and improve performance and usability.

API Used

We use two main APIs for our website:

1. "Zomato" https://developers.zomato.com/ - for restaurant data.
2. "Yummly" https://developer.yummly.com/ - for recipe data.

Apart from these APIs, we also use:

1. "MapBox" https://www.mapbox.com/ - to display maps in the website.

External Packages/Libraries

We use the following external packages:

DB Populations:

1. Python:
    a. 'requests' – to connect to the web APIs.
    b. 'MySQLdb' – to connect to the MySQL database.

Frontend:

1. HTML
2. CSS
    a. angucomplete CSS stylesheet
    b. datatables.bootstrap4 CSS stylesheet
    c. Bootstrap CSS stylesheet
    d. bootstrap-toggle CSS stylesheet
    e. MapBox CSS stylesheet
3. Javascript:
    a. JQuery Javascript library - basic library for JS, required for other libraries.
    b. Angular Javascript library – web application framework.
    c. JQuery dataTables – basic library used by the other data tables' libraries.
    d. angucomplete – used for displaying the auto complete results for ingredients.
    e. angular-datatables – used to implement the data tables in the site.
    f. datatables.bootstrap4 – used to implement the data tables in the site.
    g. Bootstrap – used to create the site's visual components.
    h. bootstrap-toggle – used to create toggle buttons.
    i. MapBox Javascript library

Backend:

1. Python:
    a. 'MySQLdb' – to connect to the MySQL database.
    b. 'simplejson' – to process jsons.
    c. 'logging' – to implement the logging feature mentioned above.
    d. 'flask' – to create the backend server.
    e. 'datetime' – to manage the timed cache mentioned above.
2. MySQL

General Flow of the App

When opening the frontend application, the site's basic layout is loaded. When the user invokes a controller function (by inputting text into an input form, or by selecting different filters and clicking the 'Search' button), the controller generates the proper request path for the required query, and requests the query's result from the backend. The controller's data retrieval handling is asynchronous: while the backend processes the request the controller keeps operating normally.

The backend then receives the request by listening on the appropriate address. The request is first decoded into the type of the request (by routing to the relevant function) and to its arguments if there are any. These arguments are either checked for validity in the decoding step or when the database is being queried. After decoding the request, it is transformed into an appropriate SQL query and then the backend queries the MySQL database in order to retrieve the result. The result is then encoded to a json object which is then returned as a value for the frontend. In the case where the result is already cached, if the cache is valid the result is returned directly from the cache without querying the database.

Finally, when the backend's response is received, the controller uses the DOMs bound to it in the HTML page and displays the data to the user.