College of Computer Science and Technology, Jilin University

– WLM Group –

Construction of visual knowledge map of diet and medical treatment

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Contents

1 Introduction

As people's attention to health and quality of life continues to grow, diet becomes increasingly crucial in maintaining physical well-being and preventing diseases. Many health issues are closely associated with individuals' dietary habits, and adopting a scientifically sound diet plan can contribute to an improved quality of life and a reduced risk of chronic diseases. However, due to fragmented information and individual differences, individuals often face challenges in selecting suitable dietary plans.

In this context, establishing a knowledge graph for medical dietary recommendations can provide personalized and scientific dietary advice for individuals. This knowledge graph will integrate expertise from various fields such as medicine, nutrition, and health science to comprehensively understand an individual's health status, medical history, lifestyle, and dietary habits. Through this knowledge graph, individuals can gain better insights into their physical condition and receive personalized dietary recommendations based on individual differences. This approach aims to provide more targeted health management in terms of diet.

2 Project Description

2.1 project objective

Personalized Dietary Recommendations: By analyzing an individual's health status, lifestyle, and dietary habits, provide personalized dietary advice to users. Considering the diverse physical conditions and needs of each person, personalized dietary plans are more conducive to enhancing the feasibility of diet implementation and user satisfaction.

Health Risk Assessment: Based on individual health information, assess potential health risks. By identifying risks such as chronic diseases and nutritional deficiencies, timely offer preventive and improvement recommendations to help users better manage their health.Interdisciplinary

Integration: Integrate expertise from various fields such as medicine, nutrition, and bioinformatics into a unified platform, promoting interdisciplinary collaboration. This integration facilitates a deeper understanding of the relationship between diet and health, laying the foundation for more research and innovation.

Promoting Health Education: Provide users with popular science information about diet, nutrition, and health through the knowledge graph. Raise public awareness of health through health education, enabling users to better understand the importance of diet to health and cultivate healthy lifestyle habits.

2.2 Purpose Formalization

Our project aims to integrate diseases, foods, and recipes to provide a comprehensive medical dietary recommendation system. To describe the various aspects considered in the project's objectives, we have outlined a set of use cases as follows:

- **Scenario 1. Fracture Patient - Zhang San** ,Zhang San is a young professional athlete who unfortunately suffered a foot fracture. He urgently needs a sensible medical dietary recommendation to promote fracture recovery.

  Personalized Needs:

High Calcium Foods: Zhang San needs to increase intake of foods rich in calcium, such as milk, yogurt, tofu, etc., to aid in the bone reconstruction process during fracture healing.

Protein Supplementation:

To support tissue repair, he needs to consume an adequate amount of protein, choosing high-protein foods like lean meat, eggs, and fish.

Vitamin D:

Due to limited sunlight exposure, he may need to promote calcium absorption through food or vitamin D supplementation.

Anti-inflammatory Foods:

Zhang San may experience some pain and inflammation, and consuming foods rich in omega-3 fatty acids (such as fish and nuts) may be helpful in reducing inflammation.

- **Scenario 2. Elderly Asthma Patient - Mrs. Wang** Mrs. Wang is an elderly asthma patient who needs a sensible medical dietary recommendation to alleviate asthma symptoms and maintain overall health.

  Antioxidant-rich Foods:

  To reduce inflammation and enhance the immune system, Mrs. Wang can increase intake of foods rich in antioxidants, such as blueberries and leafy greens.

  Low-Sodium Diet:

  Controlling salt intake helps prevent asthma attacks, so she should opt for low-sodium foods and avoid high-salt items.

  High-Fiber Foods:

  Mrs. Wang can support gut health and weight control by consuming fiber-rich fruits, vegetables, and whole grains.

  Omega-3 Fatty Acids:

  Asthma patients may consider incorporating foods rich in omega-3 fatty acids, such as fish oil and flaxseed oil, to reduce inflammation levels.

Taking into account the personas in the scenarios defined, we create Competency Questions(CQs):

1 Competency Questions

The patient is looking up the recommended diet and foods for his condition.

- **CQ 1.**What recipe does fracture patient recommend?
- **CQ 2.**What should old asthma patient notice on diet?

2 Kernel Competency Questions

- **CQ 1.** Adult, Fracture patient, Recipe
- **CQ 2.**Old, Asthma patient, Notice, Diet

3 Analysed Competency Questions

+CQ 1.

common: Person, Disease Diagnosis, Recipe

core:Fracture, Illness

contextual: Adult

+ CQ 2.

common:Person, Disease Diagnosis, Diet

core: Asthma, Notice

contextual: Elderly People

4 Classified Competency Questions

- **CQ 1.**Common OBJECTPerson, Disease Diagnosis,Recipe

Core FUNCTION:Fracture,ACTION:Illness

Contextual FUNCTION:Adult

- **CQ 2.**Common OBJECTPerson, Disease Diagnosis,Diet

Core FUNCTION:Asthma,Notice

Contextual FUNCTION:Elderly People

5 Attributed Competency Questions

- **CQ 1.**For(person):age,gender,health degree

For(Disease Diagnosis):disease infomation,syptom,accompanying disease,medicine

For(Recipe):raw material,Cooking method,state

- **CQ 2.**For(person):age,gender,health degree

For(Disease Diagnosis):disease infomation,syptom,accompanying disease,medicine

For(Diet):raw material,Cooking method,state

2.3 ER and EER

Based on the Common and Core entities, we design an Entity–relationship (ER)model as Figure 1 and Enhanced Entity-Relationship Modelling (EER) as Figure 2 .

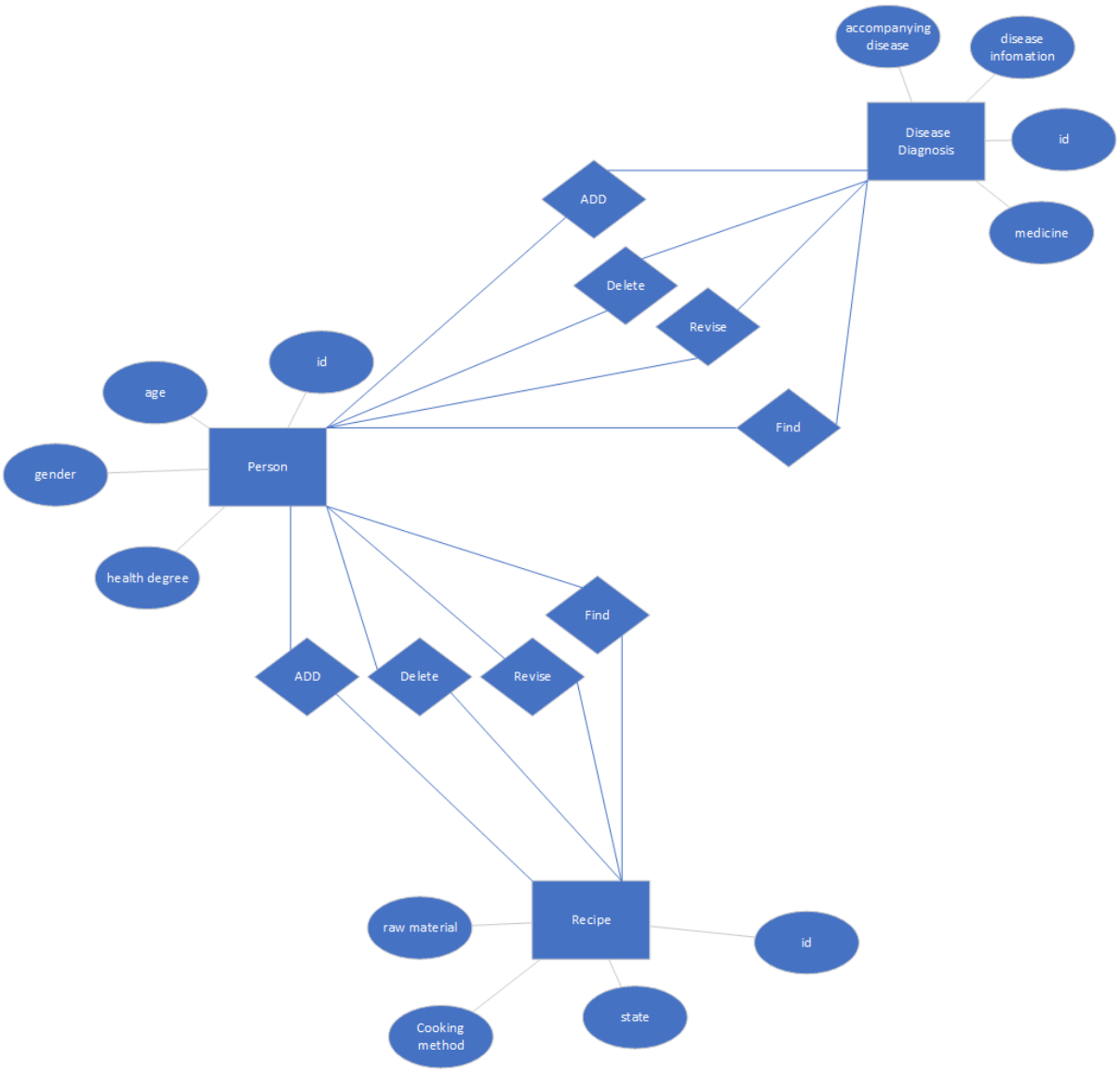
accompanying disease
disease infomation
Disease Diagnosis
id
medicine
ADD
Delete
Revise
Find
id
age
Person
gender
health degree
Find
ADD
Delete
Revise
Recipe
raw material
id
Cooking method
state

Figure 1: ER

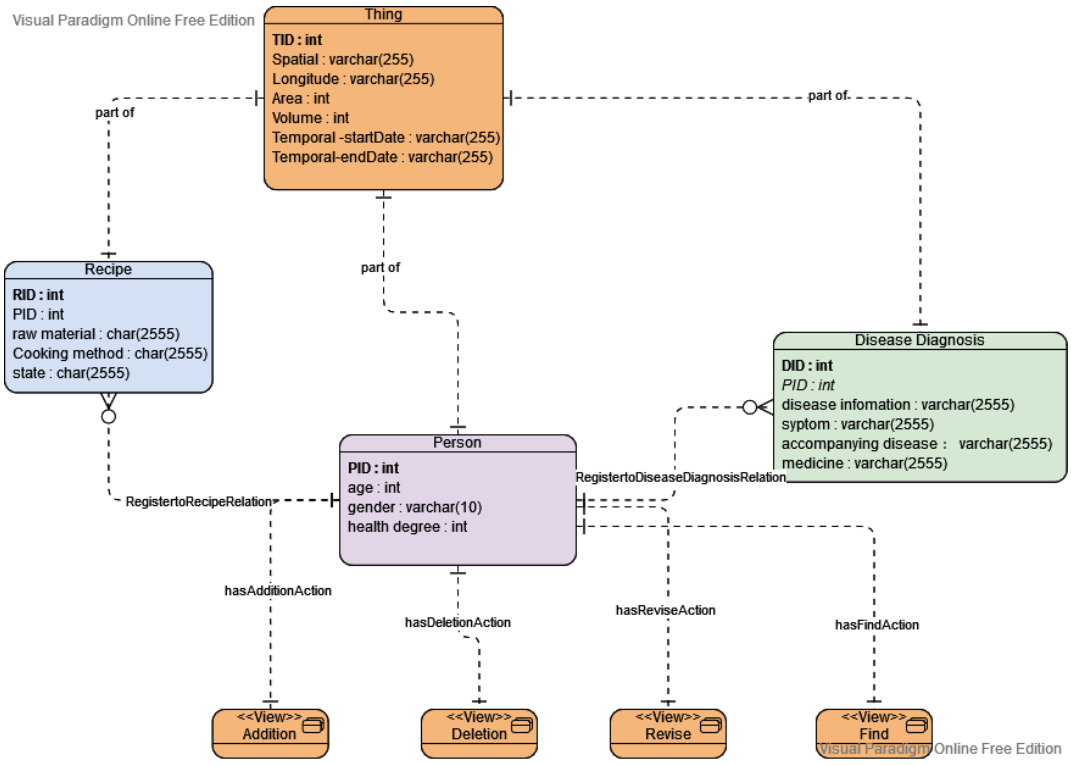

Figure 2: EER

3 Information Gathering

We specialize in providing medical dietary recommendations for patients. In order to gather sufficient dietary data related to medical conditions, we explored several websites and ultimately chose the website http://jib.xywy.com. This is a comprehensive disease encyclopedia website that includes various disease-related information, including food recommendations. We utilized Python scripts to extract data from the website and stored the information in a MongoDB database. To integrate food information with recipe details, we employed a similar approach to fetch recipe data from the website https://www.fancai.com. This site contains a variety of recipes along with ingredients and cooking methods.

3.1 Datasets metadata documentation

We have gathered two datasets, one containing information about diseases and diets, and the other comprising details about recipes. Below are the respective tables for each dataset.

Field Name	Description
Dataset Description	This dataset concludes overall information of the disease
Dataset Source	jib.xywy.com
Language	Chinese
Ownership	jib.xywy.com
URL	http://jib.xywy.com/
Format	Json
Attributes	name,desc,category,prevent,cause,symptom,yibao$_status$, get_prob, $easy_get$, $check$, do_eat, not_eat

Table 1: Information of the disease

Field Name	Description
Dataset Description	This dataset concludes overall information of the recipe
Dataset Source	fancai.com
Language	Chinese
Ownership	fancai.com
URL	https://www.fancai.com/
Format	Json
Attributes	Dish Name, Main Ingredients, Cooking Instructions

Table 2: Information of the recipe

4 Ontology construction

Ontologies are collections and frameworks of concepts, similar to classes in object-oriented programming. Its core function is to define the specialized words in a certain field and the relationship between them.

4.1 Ontology general details

Knowledge graph is structured on the basis of ontology. This paper studies the Construction of visual knowledge map of diet and medical treatment, and analyzes the entity type and semantic relationship of the map based on expert knowledge. Firstly,we extract eight kinds of ontologies, which are cheaks ontology ,departments ontology, diseases ontology, dishes ontology, drugs ontology, foods ontology, producers ontology and symptoms ontology.OWL details is shown in figure 3 .

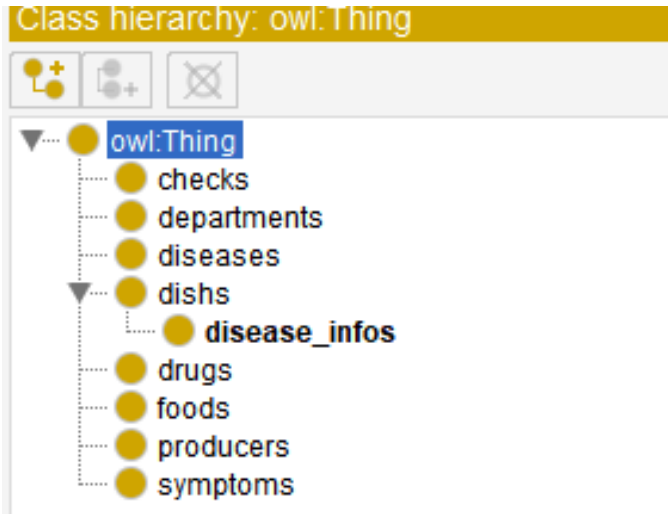

Figure 3: owl

The cheaks ontology is the examination that doctors need to do, such as "bone imaging","blood glucose" and so on; The departments ontology class is the departments that need to be registered, such as "psychiatry", "ent department" and so on. The ontology of diseases refers to the types of diseases of patients, such as "pediatric renal tuberculosis" and "liver hamartoma" and so on. The dishes ontology is a menu, such as "Chinese yam pork rib soup", "Angelica stewed pig's foot", etc. The ontological class of drugs is the drugs recommended by doctors, such as "lung tonic tablet", "kidney Kangning tablet", etc. The foods ontology is food, such as "garlic moss", "pork elbow" and so on; The ontology of producers refers to drug manufacturers, such as "Guangzhou Baiyunshan" and "Shandong Tongrentang" and so on. The symptoms ontology are the patient's symptoms, such as "binge eating" or "nosebleeds" and so on.

4.2 Ontology metadata

Among the eight ontologies, except the diseases ontology and dishes ontology, the other six metadata structures are relatively simple, consisting of id and name. Detailed examples of additional complex diseases ontologies and dishes ontologies are shown in figure 4 and figure 5

Figure 4: disease-metadata

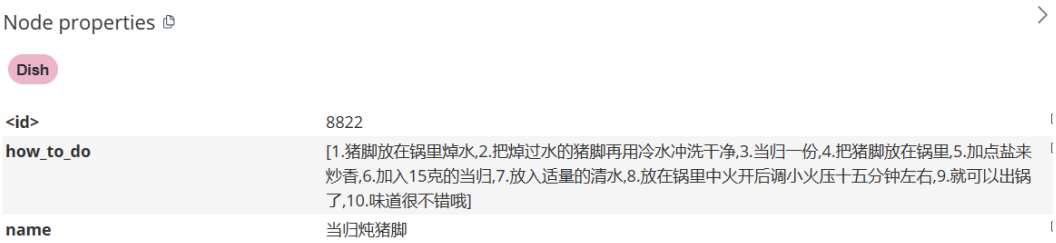

Figure 5: dish metadata

4.3 Ontological relations

Relevant instances were extracted according to ontology categories, and finally, the relationships among ontology were extracted, and a total of 11 kinds of relationships were extracted. They are belongs_to,not_eat, do_eat, commond_drugrecommand_drug, need_check, drugs_of , has_symptoms, acompany_with, rels_category and main_food.

The belongs_to describes the relationship between departments. The not_eat described the relationship between disease and food avoidance; The do_eat describes the relationship between disease and the right food to eat; The commond_drug describes the relationship between disease and generic drugs; The recommand_drug describes the relationship between a disease and a popular drug; The need_check describes the relationship between disease and examination; The drugs_of describes the relationship between the manufacturer and the drug. The has_symptoms describes the relationship between the disease and its symptoms. The acompany_with describes the relationship between disease and complications; The rels_category describes the relationship between diseases and departments.The main_food describes the relationship between a menu and the main food items

5 Knowledge integration

Above, we carried out information extraction, extracting entities, attributes and relationships among entities from medical data sources and food data sources, and forming ontology knowledge representation on this basis. The next step is knowledge integration. After acquiring the new knowledge , it is necessary to integrate it and eliminate contradictions and ambiguities. This paper is divided into the following two types.

Multiple semantic integration: Some diseases may have multiple expressions. sebaceous hyperplasia is also called Senile sebaceous gland hyperplasia. Therefore, integration should be carried out to make this disease have only one expression.

Integration of different data sources: The project begins with two original data sources being crawled. These two data sources are not related on the surface, but both are linked by the ontology of food, as shown in figure 6. Specifically, there are not-eat and do-eat attributes in the disease attribute, and there is main-food attribute in the dishes, which are food. Therefore, these two data sources can be synthesized into one through this.

Figure 6: integration

6 Knowledge graph construction

6.1 The process of building the map

According to the relationship between ontology and ontology analyzed above, we will build 8 types of class nodes and connect the nodes through 10 kinds of relations to form the knowledge graph. The node and relationship details are shown in figure 7 :

```python
def read_nodes(self):
    # 疾病部分共7类节点
    drugs = []# 药品
    foods = []#  食物
    checks = []# 检查
    departments = [] #科室
    producers = [] #药品大类
    diseases = [] #疾病
    symptoms = []#症状
    disease_infos = []#疾病信息
    # 构建节点实体关系
    rels_department = [] #  科室-科室关系
    rels_noteat = [] # 疾病-忌吃食物关系
    rels_doeat = [] # 疾病-宜吃食物关系
    rels_commonddrug = [] # 疾病-通用药品关系
    rels_recommanddrug = [] # 疾病-热门药品关系
    rels_check = [] # 疾病-检查关系
    rels_drug_producer = [] # 厂商-药物关系
    rels_symptom = [] #疾病症状关系
    rels_acompany = [] # 疾病并发关系
    rels_category = [] #  疾病与科室之间的关系
    #菜品节点
    dishs = [] #菜名
    rels_food = [] #菜名-主料关系
    dish_infos = []#菜品信息
```

Figure 7: nodes and relationships

The storage of knowledge graph data is generally based on graph database. Neo4j is the most common graph database. Therefore, this project uses Neo4j to store the built knowledge graph. Firstly, the data is read according to the above nodes and relationships, and then the entity node type of the knowledge graph is established as shown in figure **??**, and then the entity relationship edge is established as shown in figure **??**. Ultimately, we'll have the knowledge map we need. The details of the knowledge graph are shown in figure 10.

```python
'''创建知识图谱实体节点类型schema'''
def create_graphnodes(self):
    Drugs, Foods, Checks, Departments, Producers, Symptoms, Diseases, disease_infos,rels_check, rels_noteat, rels_doeat, rels_dep
    self.create_diseases_nodes(disease_infos)
    self.create_dish_nodes(dish_infos)
    self.create_node('Drug', Drugs)
    print(len(Drugs))
    self.create_node('Food', Foods)
    print(len(Foods))
    self.create_node('Check', Checks)
    print(len(Checks))
    self.create_node('Department', Departments)
    print(len(Departments))
    self.create_node('Producer', Producers)
    print(len(Producers))
    self.create_node('Symptom', Symptoms)

    return
```

Figure 8: graph-nodes

```
'''创建实体关系边'''
def create_graphrels(self):
    Drugs, Foods, Checks, Departments, Producers, Symptoms, Diseases, disease_infos, rels_check, rels_noteat, rels_doe
    self.create_relationship('Disease', 'Food', rels_noteat, 'no_eat', '忌吃')
    self.create_relationship('Disease', 'Food', rels_doeat, 'do_eat', '宜吃')
    self.create_relationship('Department', 'Department', rels_department, 'belongs_to', '属于')
    self.create_relationship('Disease', 'Drug', rels_commonddrug, 'common_drug', '常用药品')
    self.create_relationship('Producer', 'Drug', rels_drug_producer, 'drugs_of', '生产药品')
    self.create_relationship('Disease', 'Drug', rels_recommanddrug, 'recommand_drug', '好评药品')
    self.create_relationship('Disease', 'Check', rels_check, 'need_check', '诊断检查')
    self.create_relationship('Disease', 'Symptom', rels_symptom, 'has_symptom', '症状')
    self.create_relationship('Disease', 'Disease', rels_acompany, 'acompany_with', '并发症')
    self.create_relationship('Disease', 'Department', rels_category, 'belongs_to', '所属科室')
    self.create_relationship('Dish', 'Food', rels_food, 'main_food', '主料')
```

Figure 9: graph-relationships

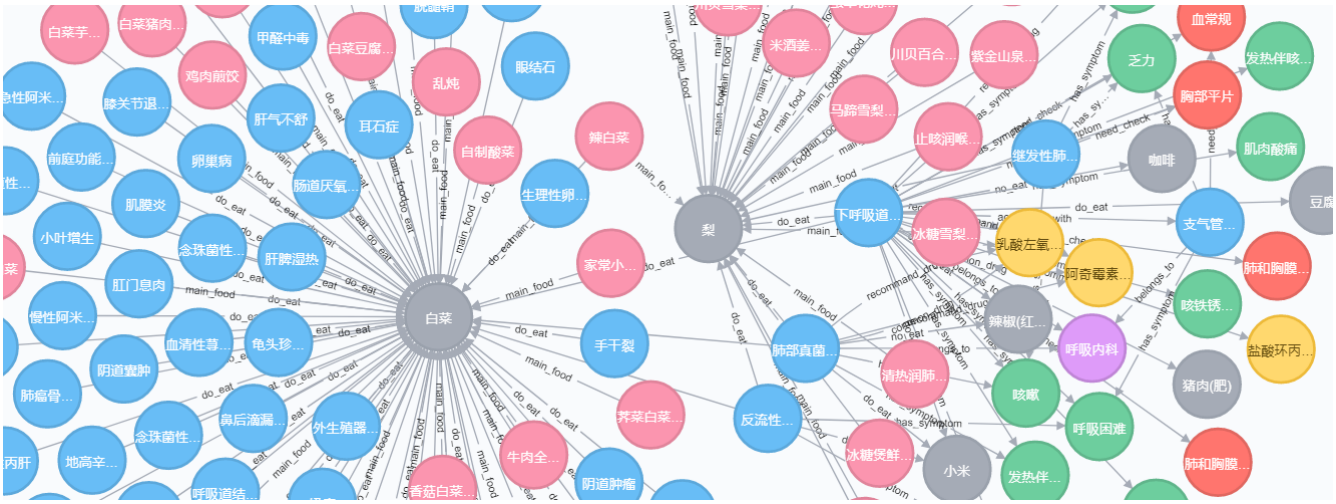

Figure 10: graph

6.2 Application example

Here, we take pneumonia as an example. If you have pneumonia, you can check the food you can't eat through this project, as shown in the figure **??**; If you have pneumonia, you can check the medication you need to take through this project, as shown in the figure 12; If you have pneumonia, you can use this project to find out what you can eat, and then you will get the recipes you need. For the convenience of patients, we recorded how to cook those recipes. Here you can find the detailed operation of these recipes. Details are shown in figure 13.

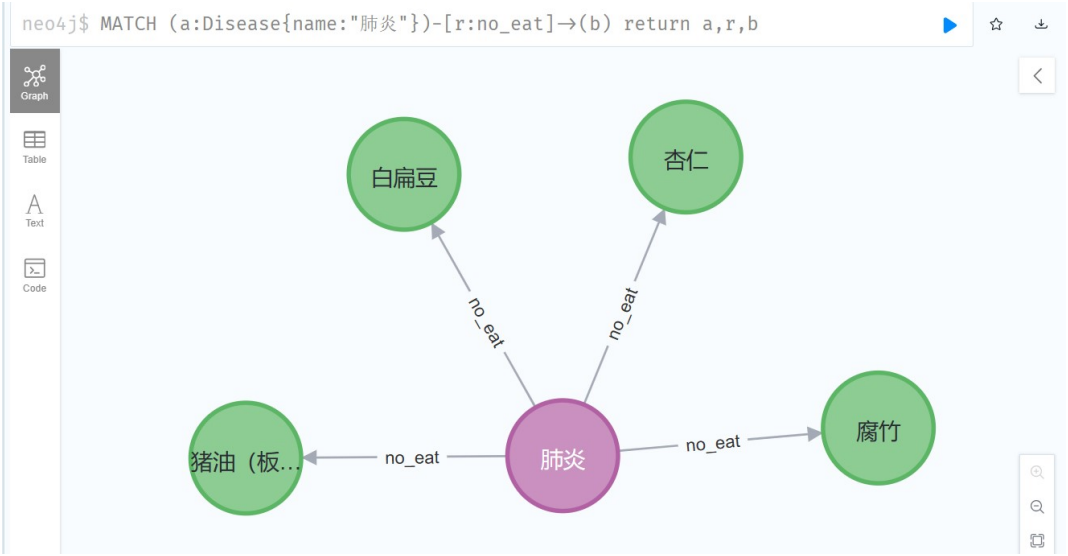

Figure 11: not-eat foods

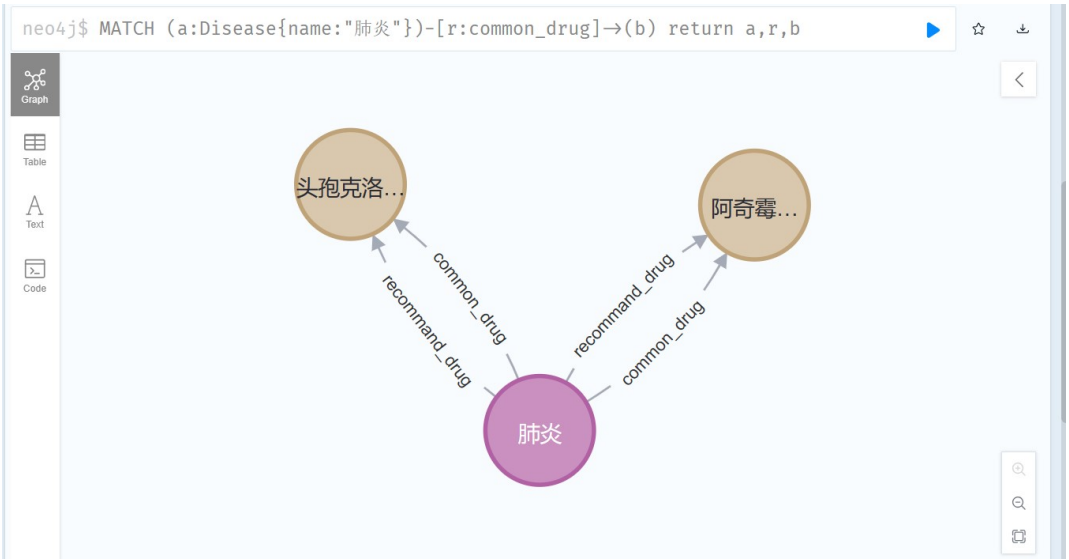

Figure 12: drugs

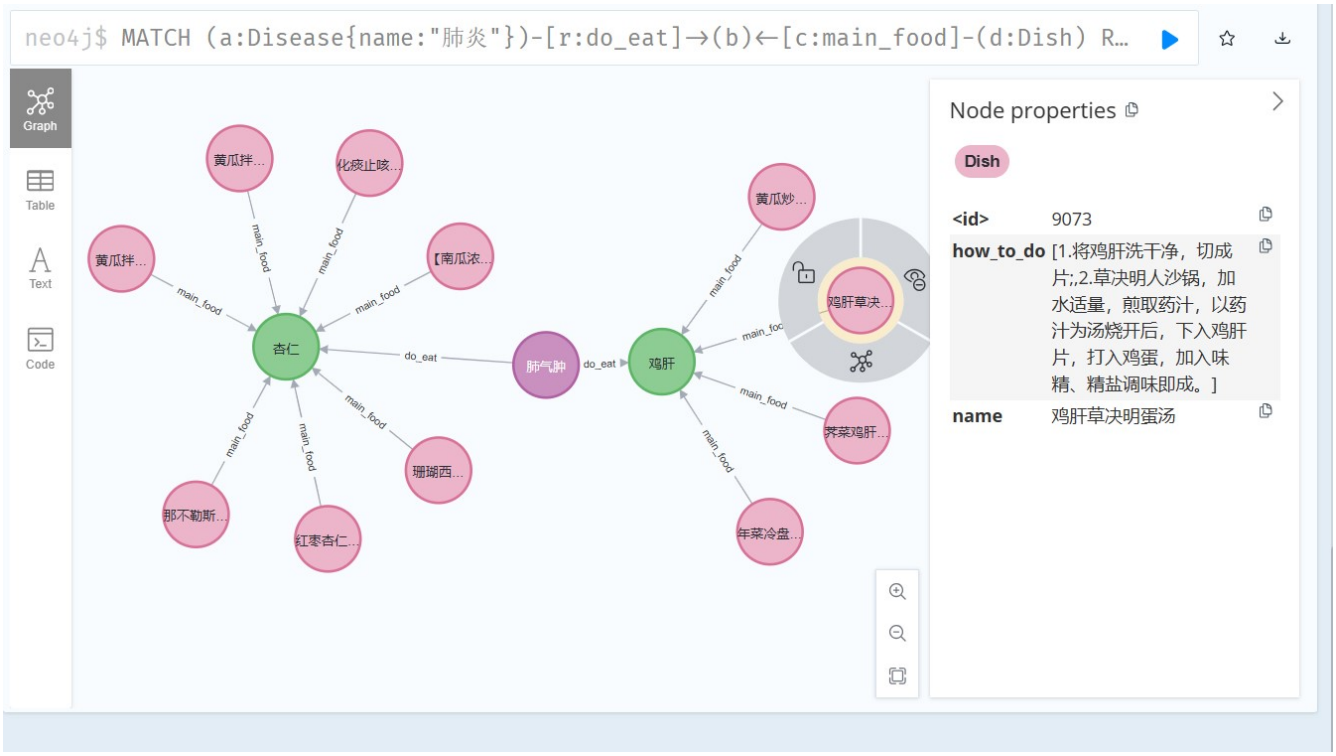

Figure 13: recipes