

Comprehensive experiment report

Subway route planning

Participants and assignment

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Summary

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Participants and assignment

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Problem description and basic requirements

Basic tasks:

1. The system can provide the **shortest distance** route calculation and recommendation function
2. The system can provide the **least stations** route calculation and recommendation function
3. The system has UI interface and display
4. The route map formation can be restored in a files (Guangzhou_railway.html)
5. Enter the names of two sites to get their **shortest distance route, least stations route**
6. The route can be displayed with the path length (number of stations or distance)

Extended functions:

1. The system can provide the **least transit stations** route calculation and recommendation function
2. Enter the names of two sites to get their **least transit stations route**
3. The recommend route can **display as a map on browser** with **interaction** function
4. The route of system is **real time data** from baidu map
5. The route plan system can plan subway routes in **all cities in China** with change the `city_code` in Map class

Tools and the knowledge used

- The system use **adjacency list** to save station message as a **directed graph**.
- The system use **dijkstra** algorithm with **priority queue** to solve the shortest path problem of non-negative weight graph.
- The system use **pywebio** to display message and implement interaction function
- Development based on **VSCode** with **Conda** environment

Analysis and implementation

data structures and algorithms choose:

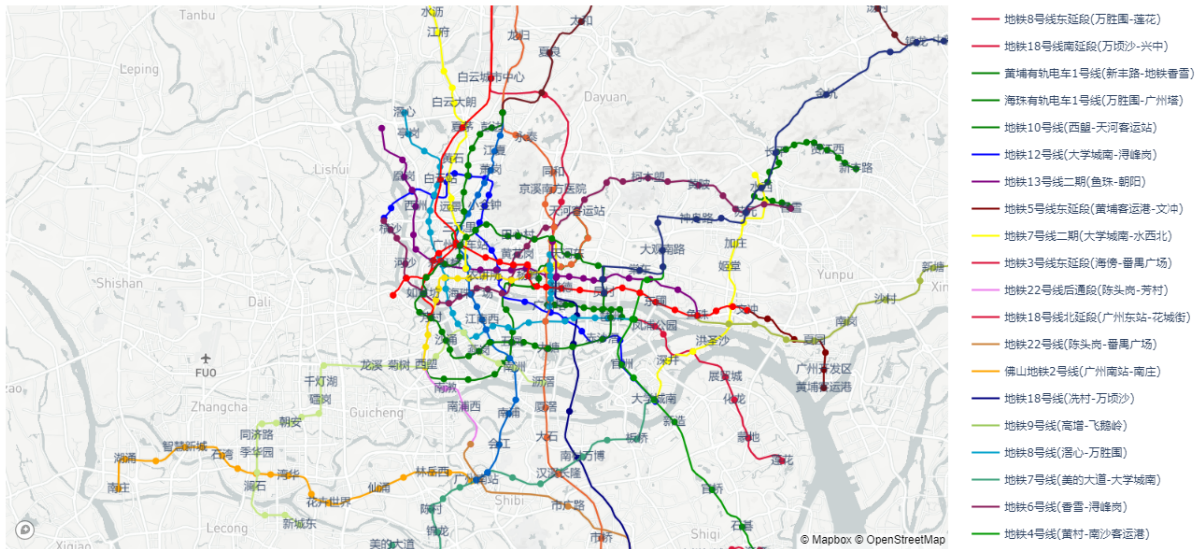
- The requirement of task is planing a shortest route on subway railways with start and end stations.
- Using **adjacency list** to load station message is suitable because its space complexity is $O(n)$ and it is especially good for sorting all the outgoing edges of a point.
- When the **priority queue** is used, if the shortest circuit of the same point is updated several times, the elements inserted in the previous update cannot be deleted or modified, but can only remain in the priority queue. Therefore, the number of elements in the priority queue is $O(m)$, and the time complexity is $O(m \log m)$.
- The subway line map is a **sparse map**. In sparse graph, $m = O(n)$, **Dijkstra** algorithm implemented by priority queue has greater efficiency advantage than Bellman-Ford algorithm; In a dense graph, $m = O(n^2)$, it is better to use brute force than priority queue.

function implement:

- Changing the weight of **dijkstra** algorithm can change the planing element between shortest distance and least station. The distance between two station is calculate by Mercator coordinates from baidu map.
- The UI interface is design by **pywebio** package, it can draw a interaction interface on browser with python code.
- The map of route display is using **plotly** package to display every element such as subway lines, subway stations, map of city and so on.
- The function of planing by least transit stations is implement by using **BFS** of graph with queue.

Testing and conclusion

A part of GZ subway graph



The input interface, you can input your start and end station.

Origin Tube Map

Select a location

Starting

Destination

提交

重置

Select the station from drop-down box

Origin Tube Map

Select a location

Starting

东山口

团一大广场

北京路

海珠广场

一德路

黄沙

如意坊

坦尾

河沙

Select the station by typing

Origin Tube Map

Select a location

Starting

黄沙

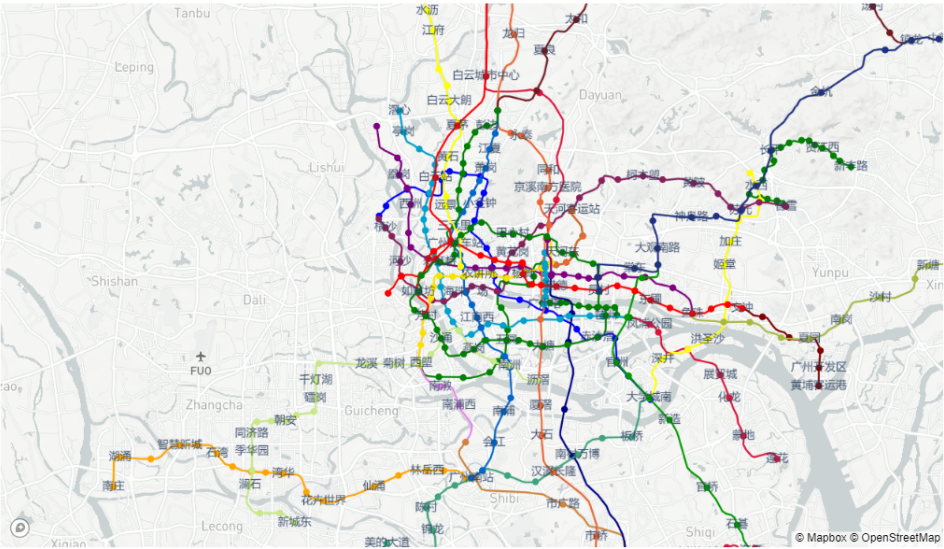
Destination

大学城

大学城南

大学城北

When you not sure the station name, you can click the blue button Origin Tube Map to check the real name from map.



- 地铁8号线东延段(万胜围-莲花)
- 地铁18号线南延段(万顷沙-兴中)
- 黄埔有轨电车1号线(新丰路-地铁香雪)
- 海珠有轨电车1号线(万胜围-广州塔)
- 地铁10号线(西塱-天河客运站)
- 地铁12号线(大学城南-谭村岗)
- 地铁13号线二期(鱼珠-新塘)
- 地铁5号线东延段(黄埔客运港-文冲)
- 地铁7号线二期(大学城南-水西北)
- 地铁3号线东延段(海傍-番禺广场)
- 地铁22号线后通段(陈头岗-芳村)
- 地铁18号线北延段(广州东站-花城街)
- 地铁22号线(陈头岗-番禺广场)
- 佛山地铁2号线(广州南站-南庄)
- 地铁18号线(庆丰-万顷沙)
- 地铁9号线(高塘-飞鹅岭)
- 地铁8号线(洛心-万胜围)
- 地铁7号线(美的广场-大学城南)
- 地铁6号线(香雪-谭村岗)
- 地铁4号线(黄村-南沙客运港)

Click the submit button

Origin Tube Map

From

黄沙

To

大学城北

Reset

▼ Shortest actual distance

Total actual distance (km)

19.495876794504987

Show map by distance

地铁6号线(浔峰岗-香雪)

1	2	3	4	5	6	7
黄沙	文化公园	一德路	海珠广场	北京路	团一大广场	东湖

地铁12号线(浔峰岗-大学城南)

7	8	9	10	11	12	13	14
东湖	二沙岛	岭南广场	赤岗	赤沙	赤沙滘	仑头	官洲

地铁4号线(黄村-南沙客运港)

14	15
官洲	大学城北

▼ Least number of station

Total station

14

Show map by station

地铁1号线(广州东站-西塱)

The frame like this

Origin Tube Map

From

黄沙

To

大学城北

Reset

▶ Shortest actual distance

▶ Least number of station

▶ Least number of transit station

The shortest actual distance recommendation message

▼ Shortest actual distance

Total actual distance (km)

19.495876794504987

Show map by distance

地铁6号线(浔峰岗-香雪)

1	2	3	4	5	6	7
黄沙	文化公园	一德路	海珠广场	北京路	团一大广场	东湖

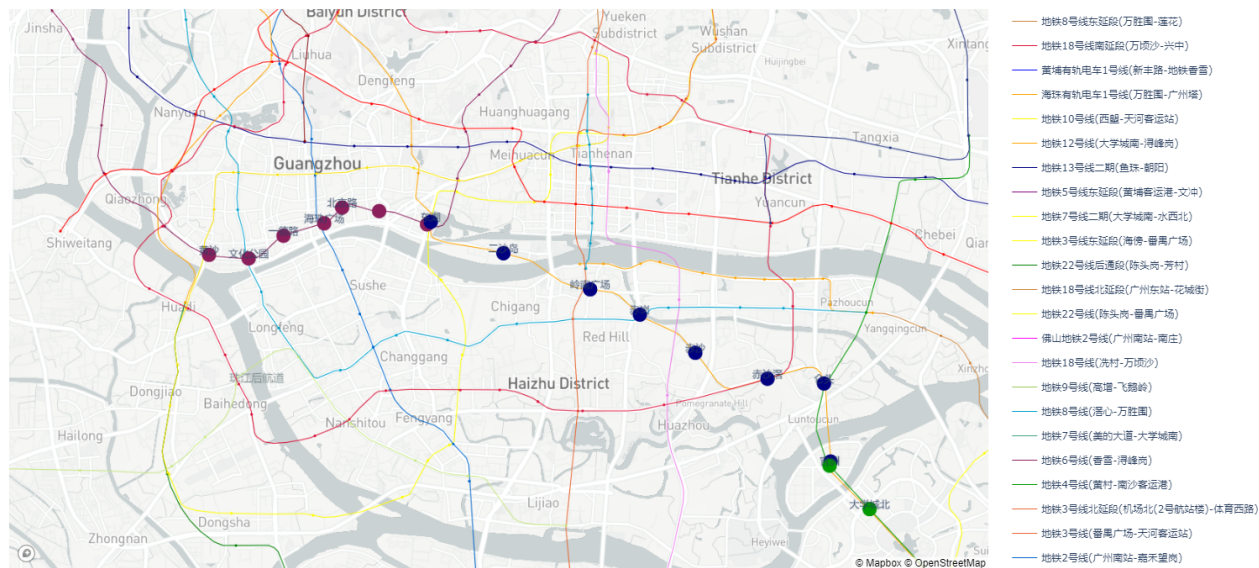
地铁12号线(浔峰岗-大学城南)

7	8	9	10	11	12	13	14
东湖	二沙岛	岭南广场	赤岗	赤沙	赤沙滘	仑头	官洲

地铁4号线(黄村-南沙客运港)

14	15
官洲	大学城北

The shortest actual distance recommendation map



The Least number of station recommendation message

▼ Least number of station

Total station

14

Show map by station

地铁1号线(广州东站-西塱)

1	2
黄沙	芳村

地铁22号线后通段(芳村-陈头岗)

2	3	4	5	6
芳村	西塱	南漵	南浦西	陈头岗

地铁22号线(陈头岗-番禺广场)

6	7	8	9
陈头岗	广州南站	市广路	番禺广场

地铁18号线(万顷沙-冼村)

9	10
番禺广场	南村万博

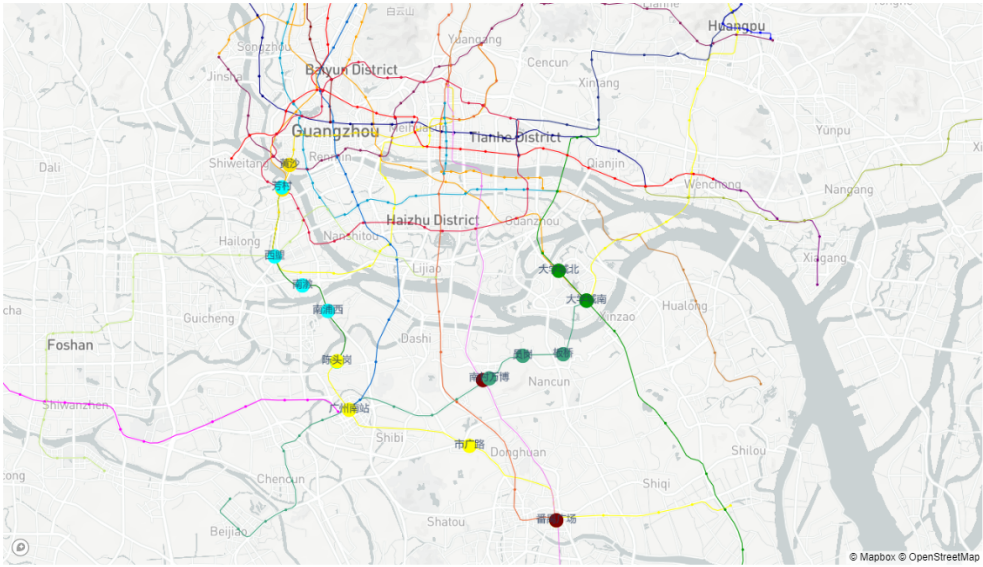
地铁7号线(美的大道-大学城南)

10	11	12	13
南村万博	员岗	板桥	大学城南

地铁4号线(南沙客运港-黄村)

13	14
大学城南	大学城北

The Least number of station recommendation map



- 地铁8号线东延段(万胜围-莲花)
- 地铁18号线南延段(万顷沙-兴中)
- 黄埔有轨电车1号线(新丰路-地铁香雪)
- 海珠有轨电车1号线(万胜围-广州塔)
- 地铁10号线(西关-天河客运站)
- 地铁12号线(大学城南-浔峰岗)
- 地铁13号线二期(鱼珠-朝阳)
- 地铁5号线东延段(黄埔客运港-文冲)
- 地铁7号线二期(大学城南-水西北)
- 地铁3号线东延段(海傍-番禺广场)
- 地铁22号线后通段(陈头岗-芳村)
- 地铁18号线北延段(广州东站-花城街)
- 地铁22号线(陈头岗-番禺广场)
- 佛山地铁2号线(广州南站-南庄)
- 地铁9号线(高塘-飞鹅岭)
- 地铁8号线(港心-万胜围)
- 地铁7号线(美的大道-大学城南)
- 地铁6号线(香雪-浔峰岗)
- 地铁4号线(黄村-南沙客运港)
- 地铁3号线北延段(机场北(2号航站楼)-体育西路)
- 地铁3号线(番禺广场-天河客运站)
- 地铁2号线(广州南站-嘉禾望岗)

The Least number of transit station recommendation message

▼ Least number of transit station

Total transit stations

1

Show map by transit stations

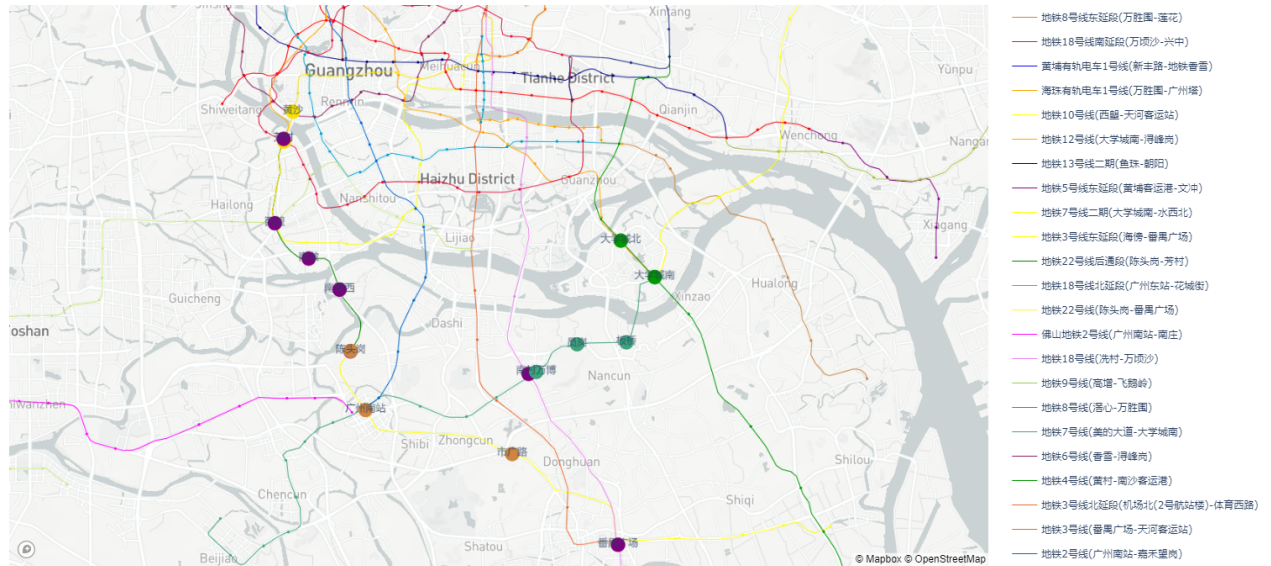
地铁6号线(香雪-浔峰岗)

1	2	3	4	5	6	7
黄沙	文化公园	一德路	海珠广场	北京路	团一大广场	东湖

地铁12号线(大学城南-浔峰岗)

7	8	9	10	11	12	13	14	15
东湖	二沙岛	岭南广场	赤岗	赤沙	赤沙滗	仑头	官洲	大学城北

The Least number of transit station recommendation map



Last, you can click the reset button to input the station again.

The program meets the requirements of this comprehensive experiment.

Summary

The algorithm of this system does not have many characteristics. Algorithms and data structures are relatively efficient. Double Breadth First Search can be used to reduce the time complexity of the algorithm when planning the route with the least transfer stations. I think the system more outstanding that its interactive mode is more intuitive, and can draw real-time circuit diagram. The system can also easily switch to the subway line map of all cities in the country, the system has high reusability. In addition, the system also encapsulates the line drawing device, which can be reused quickly when drawing other types of line drawing except subway. I think this course is better taught in C/C++, and python's over-encapsulation makes the implementation of algorithms very slow. In contrast, the Pointers and actionable memory features of C/C++ help us understand and learn data structures.